Exhibit 7

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Competition in the Audit Market: Policy Implications

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ABSTRACT

The audit market's unique combination of features—its role in capital market transparency, mandated demand, and concentrated supply—means it receives considerable attention from policy makers. We explore the effects of two market scenarios that have been the focus of policy discussions: mandatory audit firm rotation and further supply concentration due to the exit of a "Big 4" audit firm. To do so, we first estimate publicly traded firms' demand for auditing services, allowing the services provided by each of the Big 4 to be differentiated products. We then use those estimates to calculate how each scenario would affect client firms' consumer surplus. We estimate that, for U.S. publicly trade firms, mandatory audit firm rotation would induce consumer surplus losses of approximately $2.7 billion if rotation were required after 10 years and $4.7–5.0 billion if after only four years. We find similarly that exit by one of the Big 4 would reduce client firms' surplus by $1.4–1.8 billion. These estimates reflect only the value of firms' lost options to hire the exiting audit firm; they do not include likely fee increases resulting from less

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competition among audit firms. The latter could result in audit fee increases between $0.75–1.3 billion per year for mandatory rotation and $0.47–0.58 billion per year for the disappearance of a Big 4 audit firm. Such losses are substantial; by comparison, total audit fees for public firms were $11 billion in 2010.

JEL codes: L84; M41; M42; M48

Keywords: auditing; mandatory rotation; competition

1. *Introduction*

The market for financial audits exhibits a set of features that distinguish it from other markets for business services (and for that matter, many other goods more broadly). First, it is seen by many to play an important and, in some ways, unique role in preserving transparency and improving the functioning of capital markets (e.g., Watts and Zimmerman [1983], Black [2000–2001], Ball [2001]). Relatedly, failures of auditors to catch and report improprieties are often highly—and occasionally spectacularly—visible.

Second, a substantial portion of demand in the market is mandated. Publicly traded firms are compelled to purchase audit services, and there are no services from outside the industry that can legally serve as substitutes.

Third, the market's supply side is highly concentrated. Among publicly traded companies in the United States, for example, the majority of audit engagements and almost all audit fees involve just four audit firms (the "Big 4": Ernst & Young, Deloitte, KPMG, and PricewaterhouseCoopers). In 2010, the Big 4 handled 67% of audit engagements and collected over 94% of audit fees.[1] As discussed by Velte and Stiglbauer [2012], audit markets in many other developed economies exhibit similar concentration.

The combination of these features has resulted in the audit industry being the subject of frequent policy debates. In this paper, we explore two oft-recurring discussions in this vein. The first regards the consequences of imposing a mandatory audit firm rotation policy. The second involves the effects of further concentration in supply due to one of the Big 4 audit firms exiting the market.

Both of these scenarios have already colored policy toward the industry. The Public Company Accounting Oversight Board (the "PCAOB") is in active discussions about implementing a mandatory audit firm rotation policy for publicly traded firms. During the PCAOB's hearings in March 2012 on mandatory audit firm rotation, panelists voiced opposing views about the costs and benefits of a mandate. For example, the executive director of the AICPA's Center for Audit Quality stated that mandatory audit firm rotation would hinder audit committees in their oversight of external auditors, while former SEC chairman Arthur Levitt supported mandatory rotation because

[1] For a breakdown of market shares and fees over the recent decade, see tables 1 and 2.

"investors deserve the perspectives of different professionals every so often, particularly when an auditor's independence can be reasonably called into question" (Tysiac [2012]). Moreover, Congress has moved to address the issue of mandatory audit firm rotation. In June 2013, the U.S. House overwhelmingly passed a bill to prohibit the PCAOB from mandating audit firm rotation (Cohn [2013]), though the Senate has yet to take corresponding action.

With regard to the disappearance of a Big 4 firm, there have been several recent cases in which a Big 4 audit firm could arguably have been criminally indicted but the Department of Justice decided to not file charges, probably because of concerns about further increasing concentration.[2] For example, in 2005 KPMG admitted criminal wrongdoing by creating tax shelters that helped clients evade $2.5 billion in taxes. Nevertheless, the Department of Justice did not indict KPMG and instead entered into a deferred prosecution agreement (Johnson [2010]). Moreover, according to the Lehman Brothers bankruptcy examiner's report (Valukas [2010]), Ernst & Young assisted Lehman Brothers in implementing its Repo 105 transactions, which allowed Lehman to temporarily reduce its leverage when preparing its financial statements. Nonetheless, the Department of Justice did not pursue criminal charges against Ernst & Young.[3]

We seek to explore how the fruition of these two scenarios—the imposition of mandatory audit firm rotation and the disappearance of one of the Big 4—would affect the audit market, and in particular the consequences for publicly traded firms, its primary customers. Addressing these questions satisfactorily requires, at the very least, measurements of the willingness of firms to substitute among individual audit firms and the value firms place (if any) on extended relationships with audit firms. However, prior research on the structure of the audit market has focused on other questions, primarily on either correlations between audit fees and firm characteristics or substitutability between the Big 4 and non–Big 4 groups.[4] While this work has offered insights into several questions, its focus on separate issues has left a gap that we seek to begin to fill with this study.

To obtain the necessary measures of firms' willingness to substitute among specific audit firms and the value firms place on extended relationships with audit firms, we estimate the demand for audit services among publicly listed firms. We conceptualize firms seeking audit services as choosing from among several producers of those services (i.e., the audit firms),

[2] A criminal conviction prohibits an audit firm from carrying out audits of SEC registrants.

[3] In contrast, the New York attorney general Andrew Cuomo sued Ernst & Young, claiming that the audit firm helped Lehman "engage in a massive accounting fraud" (Public Accounting Report [2011]).

[4] For a review of studies that examine the association between audit fees and client characteristics, see Causholli et al. [2011]. For examples of studies that examine substitutability between the Big 4 and non–Big 4 groups, see Willenborg [1999], Ettredge, Kwon, and Lim [2009], Lennox, Francis, and Wang [2012], and Guedhami, Pittman, and Saffar [2014].

with each potential audit firm offering varying aspects of service that are potentially valued differentially by each client firm. Each client firm considers how well the attributes of each audit firm's product match its needs (these attributes include price—the audit fees) and hires the audit firm offering the best net value. The resulting demand model yields quantitative predictions about how client firms' characteristics (assets, industry segments, and foreign sales activity, for instance) and audit firms' attributes (brand names, fees, and prior history with potential clients, for instance) affect client firms' choices of audit firms.

This framework allows us to use data on client firms' audit firm choices to measure in dollar terms the values they put on substitutability among and prior relationships with specific audit firms. For example, if we observe a particular firm hiring an audit firm despite the fact that the expected fees from hiring an alternative audit firm would be $1 million lower, we can infer that the firm values something about the hired audit firm at a premium that is at least this large. Combining this information across thousands of client firms' choices tells us what audit firm attributes different clients value and by how much. Of particular importance to our investigation here, this allows us to calculate the monetary transfer that would be necessary to compensate client firms who lose a potential audit firm choice due to the exit of a Big 4 audit firm, and to measure clients' willingness to pay for longer term relationships with a particular audit firm and the value client firms would lose if forced to break such relationships because of mandatory audit firm rotation. Thus, we can address quantitatively some of the key policy questions surrounding the issues of further audit firm concentration and mandatory audit firm rotation.

This revealed preference demand estimation framework, where buyers' actual choices are used to infer the qualitative and quantitative factors that underlie their decisions, is common in many fields of economics, though it has been applied less frequently in the accounting literature. It is well suited to answering the questions here, however. (Every empirical method has its limitations, of course, and we will discuss these in the context of our analysis below.)

The framework treats the audit market much like any other differentiated product market (even the mandatory nature of audit demand can easily be handled within our framework).[5] Differentiation implies that clients do not view all audit firms as providing services that are perfect substitutes. This can occur due to switching costs and/or clients differentially valuing the services provided by each audit firm. It is worth noting, however, that our empirical approach neither assumes nor imposes differentiation. It instead allows for potential differentiation among the Big 4 audit firms and lets client firms' actual choices in the data speak as to its existence. In this

[5] Because audits are inputs into firms' production activities, these are differentiated factor markets, but the economics are essentially the same as in markets for differentiated outputs.

way, our approach contrasts with prior research that assumes a priori that there is no differentiation among the Big 4 (e.g., Doogar and Easley [1998], Sirois and Simunic [2013]). Nondifferentiation is testable: if audit firms are not differentiated, all choices of audit firms should be driven by fees alone. This is clearly rejected in the data, as will be seen below; audit firms' nonprice attributes affect client firms' decisions, and many clients choose audit firms that charge fees that are higher than other audit firms' projected fees for that client. Moreover, price elasticities are in the range of negative two or three, far from the negative infinity implied by nondifferentiation. Further still, as we describe later, client firms' choices indicate that their preferences among the Big 4 depend on specific financial attributes of the client (such as their size, share of foreign operations, and even profitability).

Our analyses indicate that mandatory audit firm rotation would result in substantial losses in client firms' expected consumer surplus. Consumer surplus in this market is the total value client firms place on their purchased audit services in excess of the fees they pay for them. As such, this is the key measure of the net benefit the audit market delivers to its buyers, the client firms. We estimate that, conservatively, client firms' consumer surplus will fall by approximately $2.7 billion if rotation were required after 10 years and $4.7–5.0 billion if rotation were mandatory after only four years. This lost surplus can be interpreted as the total amount of cash transfers client firms would require to compensate them for the inability to hire their current audit firm.[6] We also find large impacts from the exit of any of the Big 4 audit firms, estimating consumer surplus losses at approximately $1.4–1.8 billion per year depending on the identity of the exiting audit firm.

These figures reflect only the direct effect of the loss of audit firm choice; they do not account for the likely increases in audit fees that would occur due to less competition among the remaining audit firms. Using our data to estimate the latter effect, we calculate mandatory audit firm rotation could result in audit fee increases between $0.75 and $1.3 billion per year and moving from the Big 4 to the Big 3 could result in audit fee increases between $0.47 and $0.58 billion per year. As higher fees correspond dollar-for-dollar with lost consumer surplus, this supply response effect exacerbates the pure choice effect. Both of these losses are substantial; by comparison, total audit fees for public firms were $11 billion in 2010.

These estimates carry several caveats. First, the Big 4 audit firms operate worldwide, though our estimates are based only upon their U.S. public clients. Second, due to a lack of data, we are also unable to include private firms in our analysis, but they would also suffer losses in surplus.

[6] Note that the existence of consumer surplus is in no way inconsistent with audit firms, and the Big 4 in particular, exercising market power. Standard economic theory indicates that even a monopolist, unless it is able to engage in perfect price discrimination (i.e., charging every single consumer a price that exactly equals their maximum willingness to pay), will leave consumers some surplus.

Furthermore, our estimates are limited to audit fees and services and do not take into account non–audit-related fees and services. Nevertheless, these estimates are informative about the costs that could arise from changes in the audit industry's market structure and from the implementation of mandatory rotation. Furthermore, they provide some of the first estimates of the value of audit firm-client matches. That said, we cannot rule out that the estimated changes in consumer surplus reflect the influence of agency costs. Under this interpretation, audit committees do not choose audit firms solely to maximize expected shareholder wealth, but instead allow rent extraction motives to influence their choice of audit firms.

Reflecting their status as topics of debate, it is important to point out that there may be benefits from both mandatory audit firm rotation and audit firm exit as well. For example, the threat of exit due to either market or government response to malfeasance or negligence could discipline moral hazard, and mandatory rotation could resolve rent-seeking behaviors supported by overly cozy relationships between audit firms and clients. Quantifying those benefits requires an analytical approach that is beyond the scope of this paper. Our estimates, however, offer a measurement of the costs of additional concentration and mandatory rotation that an optimal policy would balance any benefits against.

The analyses in this paper are obviously relevant to those directly interested in the specific policy-relevant audit industry counterfactuals that we examine. However, we believe more general lessons can also be drawn from the analyses. They offer a framework for investigating sets of demand, supply, and competitive issues in the audit market that extend well beyond the two we investigate here. Indeed, there are entire literatures dedicated to examining these issues in this special market. Our framework, which has been applied in similar forms in other market settings but (to our knowledge) is novel to research on the audit market, lets researchers quantify and isolate demand- and supply-side fundamentals that offer richer answers to questions about the nature and effects of the audit market than previously available. Furthermore, our approach can be used to analyze the markets for business services more broadly (e.g., credit ratings, investment banking, and commercial banking), which are extensive in size and scope.

Our analysis is structured as follows. We first discuss how we model client firms' choices of audit firm. We then describe the estimation of our demand model, including our approaches for dealing with the key issue of price endogeneity. We also explain how we handle a more atypical situation in demand estimation: the fact that we do not observe prices (fees) for producers (audit firms) that a firm does not hire. Then, after reporting and discussing our demand estimates, we use these estimates to calculate the expected effects of the two counterfactual scenarios described above: greater audit industry concentration and mandated audit firm rotation.

2. *Demand Model*

Although publicly traded firms are compelled to purchase an audit ("mandated demand"), they can choose among audit firms certified by the PCAOB. We therefore model publicly listed firms' demand for audit services as reflecting a choice among several potential audit firms: each of the Big 4 and an amalgam alternative option that includes all other audit firms. Each client firm makes its choice based on the expected benefit it would obtain from hiring each of the audit firms. This benefit includes the effects of firm-, auditor-, and match-specific attributes and is net of the fees the audit firm charges the client firm for its services.

While the discrete choice demand model we lay out later is in many ways standard in the economics literature (especially within the field of industrial organization), our approach differs from the substantial prior research on audit firm choice, in that this work has typically examined the simple dichotomous choice between using a Big 4 or a non–Big 4 audit firm. Our structure allows us to more fully characterize substitution patterns among individual audit firms, and, just as importantly, lets us tie client firms' choices directly to parameters of their factor demands, a key to quantifying preferences in terms of dollar values.

2.1 UTILITY SPECIFICATION

For firms' choice of audit firm, we specify the "inside" goods as the Big 4 audit firms (Ernst & Young, Deloitte, KPMG, and PricewaterhouseCoopers) and the "outside" good as the aggregation of all other audit firms that provide audits to public firms (BDO Seidman, Grant Thornton, etc.).[7] Because we are identifying the preference parameters of publicly listed firms whose demand for audit services is mandated, there is no true outside good in this setting. Thus, we can simply define the outside good as any audit firm choice not in the Big 4. In fact, mandated demand makes our task easier, as we do not need to be concerned with defining the full breadth of potential demand for the market, a necessary assumption in discrete choice settings where buyers might not purchase any product in the market.

We model each client firm i's utility from choosing a Big 4 audit firm j as:

$$U_{ij} = \delta_{ij} - \alpha \ln(p_{ij}) + \beta_j x_{ij} + \epsilon_{ij}, \tag{1}$$

in which δ_{ij} is an audit firm brand effect (which we allow to vary across clients as described below) that represents the mean utility that client i obtains from choosing audit firm j; p_{ij} is audit firm j's price for an audit of firm i (i.e., its audit fees); α parameterizes the marginal willingness to pay for a log-dollar of audit fees; x_{ij} is a vector of observable nonprice

[7] In contrast with Simunic [1980], we do not assume that the non–Big 4 segment is perfectly competitive. In fact, our demand model requires no assumptions about the competitive nature of either the Big 4 or non–Big 4 segments of the market.

characteristics of the client-audit firm pair; β_j are the utility loadings on these characteristics; and ϵ_{ij} is an unobserved client-audit firm specific utility component assumed to be independently and identically distributed.[8] In our specification, audit fees enter in logarithmic form. This log specification implies that an additional dollar of audit fees matters less to a large client than a small client and is consistent with the log price specification commonly used in audit fee regressions.

Because we observe the price of the outside good, we model client firm i's utility from choosing a non–Big 4 audit firm k as:

$$U_{ik} = -\alpha \ln(p_{ik}) + \epsilon_{ik}. \tag{2}$$

This approach allows for changes in market structure to affect clients' preferences for non–Big 4 firms. It differs from more common situations in which the outside good is not observed, and utility from the outside good is therefore normalized to zero.

To model the interactions between nonprice characteristics of the client firm and the Big 4 audit firm, we expand x_{ij} as follows. First, we interact an audit firm fixed effect, δ_{ij}, with the natural logarithm of the client's size, $ln(\textit{Total Assets}_i)$. This interaction allows us to capture audit firm preferences that vary with client firm scale. For example, smaller firms may prefer non–Big 4 audit firms, and there could be heterogeneous size-based preferences across each of the Big 4 audit firms. Second, we interact the audit firm fixed effects with an additional set of client characteristics commonly used in the audit literature: $ln(\textit{Segments}_i)$ is the natural logarithm of the number of industrial segments in which the client operates; $\textit{Foreign Sales}_i$ is the ratio of foreign to total sales; $\textit{Debt}_i$ is the ratio of short plus long-term debt to total assets; $\textit{ROA}_i$ is the client's return on assets; $\textit{Inventory} + \textit{Receivables}_i$ is the ratio of inventory plus accounts receivables to total assets; $\textit{Payables}_i$ is the ratio of accounts payable to total assets. These interactions allow rich variation in preferences for audit firms across client firms with different operating and financial characteristics. Third, there is a large literature on audit firm industry specialization (e.g., O'Keefe, King, and Gaver [1994], Craswell, Francis, and Taylor [1995], Hogan and Jeter [1999], Carson [2009]). We therefore interact the audit firm fixed effects with industry indicators (using the Fama-French 10-industry classification system) to allow for any systematic preference differences across clients' industries. Fourth, there is a literature that examines competition among the Big 4 audit firms on a local level (e.g., Francis, Reichelt, and Wang [2005], Numan and Willekens [2012]). To capture potential client preferences for audit firms that have a nearby office, we create indicator variables for whether the Big 4 firm has an office in the same Metropolitan Statistical Area (MSA) as the client's headquarters. To identify the differential effect of having a local office, we

[8] While we have described equation (1) as reflecting a client firm's utility, it can be interpreted more broadly as any objective function of the client with respect to its audit firm choice.

TABLE 1
Market Shares

Panel A: Market shares based on audit fees

	E&Y	Deloitte	KPMG	PwC	Non-Big 4	HHI SIC3
2002	22.50%	18.88%	23.92%	31.55%	3.15%	4,957
2003	23.15%	19.78%	21.71%	32.11%	3.25%	4,955
2004	22.40%	20.71%	21.41%	32.17%	3.31%	5,157
2005	23.64%	21.44%	20.38%	29.93%	4.62%	5,111
2006	24.22%	20.96%	20.19%	29.41%	5.22%	5,133
2007	25.24%	22.17%	19.52%	27.04%	6.04%	4,979
2008	24.21%	22.32%	19.44%	28.16%	5.85%	4,968
2009	25.06%	21.74%	18.71%	28.89%	5.59%	5,070
2010	25.21%	21.35%	18.93%	29.23%	5.28%	5,050

Panel B: Market shares based on number of clients

	E&Y	Deloitte	KPMG	PwC	Non-Big 4	HHI SIC3
2002	23.86%	16.71%	19.93%	22.15%	17.35%	3,832
2003	23.16%	16.39%	19.16%	21.65%	19.64%	3,785
2004	21.45%	15.97%	18.32%	20.42%	23.84%	4,034
2005	21.03%	15.59%	16.49%	18.04%	28.86%	4,096
2006	20.85%	14.86%	15.61%	16.64%	32.04%	4,195
2007	20.83%	14.53%	14.51%	15.75%	34.38%	4,114
2008	20.78%	14.44%	14.37%	15.77%	34.63%	4,191
2009	20.82%	14.65%	14.59%	15.58%	34.35%	4,260
2010	20.95%	14.94%	15.16%	16.03%	32.93%	4,262

This table presents annual market shares of SEC registrant audits for the Big 4 and non–Big 4 audit firms as well as the mean Herfindahl Index of those shares within three-digit SIC industries. Panel A calculates market shares and Herfindahl Indices based on audit fees and panel B calculates market shares and Herfindahl Indices based on number of clients. Audit fees and clients are taken from the Audit Analytics database.

code the indicators to zero if all of the Big 4 firms have an office in the MSA.

The model assumes client firms make an audit firm choice every year. PCAOB standards do in fact require an annual engagement letter, and the SEC requires audit committees to evaluate and ratify audit contracts annually. Nevertheless, the data reveal a strong tendency to rehire the previous year's audit firm. Over the period 2002–2010, for example, the probability of renewing an existing audit firm relationship was in the neighborhood of 94% (see table 3). This persistence could reflect the effect of match-specific capital formed during the course of an auditing relationship or reveal the strength of some other match-specific unobservable utility component that makes retention more likely.[9] To parsimoniously incorporate any such effects, we add elements to equation (1) that allow for the possibility that rechoosing the prior year's audit firm will deliver additional utility. Specifically, we interact the audit firm fixed effects with two additional variables:

[9] It does not, however, reflect any contractual switching costs. Termination penalties or "walk-away fees" for switching audit firms are considered contingent fee arrangements and as such are prohibited under AICPA and PCAOB independence rules.

TABLE 2
Distribution of Audit Fees

Panel A: Full sample						
Year	Firms	Mean	Std. Dev.	Q1	Median	Q3
2002	5,775	890,263	3,055,706	115,000	237,000	597,408
2003	5,907	1,076,897	3,097,653	134,011	296,900	757,680
2004	5,856	1,753,816	5,120,930	185,000	545,388	1,420,690
2005	5,877	1,893,852	4,852,954	225,000	640,000	1,608,780
2006	5,799	2,149,814	5,420,347	245,000	712,206	1,783,760
2007	5,727	2,134,638	5,332,254	258,450	740,659	1,800,000
2008	5,414	2,225,593	5,756,625	280,000	752,250	1,804,000
2009	5,071	2,148,250	5,870,241	276,600	735,000	1,674,240
2010	5,008	2,150,459	5,788,977	281,600	735,000	1,713,000
Panel B: Fixed sample						
Year	Firms	Mean	Std. Dev.	Q1	Median	Q3
2002	2,567	1,118,127	2,900,624	125,000	283,800	758,230
2003	2,567	1,406,201	3,806,017	159,520	363,000	946,000
2004	2,567	2,299,959	5,445,346	251,000	721,050	1,866,830
2005	2,567	2,532,946	5,984,146	325,398	837,066	2,174,570
2006	2,567	2,816,801	6,402,031	362,750	951,600	2,479,810
2007	2,567	2,871,367	6,224,569	403,500	996,000	2,542,330
2008	2,567	2,960,644	6,813,149	409,000	1,000,000	2,563,860
2009	2,567	2,869,934	7,150,467	400,000	964,960	2,340,940
2010	2,567	2,846,895	7,068,154	390,095	942,000	2,323,790

This table presents annual mean and median audit fees for our sample of SEC registrants. Panel A reports the means and medians for all sample firms, while panel B reports the annual mean and median fees for a constant subsample of firms that appear in the sample every year. Audit fees are taken from the Audit Analytics database.

an indicator that equals one if the client firm did not use the respective audit firm in the prior year, $1(\textit{Not client}_{ij})$, and the natural logarithm of the number of consecutive years that the client firm has hired to its current audit firm, $ln(\textit{YearsClient}_{ij})$.[10]

Given this utility function, a client firm's choice decision is straightforward. Each year, client i calculates U_{ij} for each of its five options (the Big 4 firms and the outside good) and then chooses the audit firm j that provides the maximum U_{ij}.[11]

[10] We define this latter variable as zero for Big 4 firms that are not the client firm's current audit firm; thus, the "not client" indicator coefficient reflects the difference in demand between an audit firm with which the client firm does not have a current relationship and an audit firm with which the client has been matched for one year.

[11] In estimation of the model below, we typically include all five options in a client firms' choice set. In a few specific cases, however, we assume a more restricted set. Namely, we remove any auditing firm that resigned from auditing the client in the prior three years. (We identify such resignations using the Audit Analytics database.) Such resignations arise from disagreements over fees, accounting practices, or issuances of going concern opinions. In addition, the Sarbanes-Oxley Act prohibits audit firms from providing certain consulting services to their clients. Unfortunately, we are unable to impose any restrictions on clients' choice sets due to such consulting relationships with audit firms because information on these

TABLE 3
Audit Firm Switches

		Year *t+1*					
		E&Y	Deloitte	KPMG	PwC	Non–Big 4	Total
Year *t*	E&Y	8,609	55	80	59	276	9,079
		94.8%	*0.6%*	*0.9%*	*0.7%*	*3.0%*	
	Deloitte	71	6,062	50	60	235	6,478
		1.1%	*93.6%*	*0.8%*	*0.9%*	*3.6%*	
	KPMG	81	49	6,574	51	250	7,005
		1.2%	*0.7%*	*93.9%*	*0.7%*	*3.6%*	
	PwC	74	94	62	7,224	247	7,701
		1.0%	*1.2%*	*0.8%*	*93.8%*	*3.2%*	
	Non–Big 4	75	48	68	49	10,973	11,213
		0.7%	*0.4%*	*0.6%*	*0.4%*	*97.9%*	
	Total	8,910	6,308	6,834	7,443	11,981	

This table presents the audit firm transition matrix of clients between audit firms over the period 2002–2010. The percentages in italics are relative to the row totals.

2.1.1. Assumptions and Limitations. The demand model outlined earlier is a form of the commonly used logit model. This framework is commonly used in the economics literature (and elsewhere, such as in marketing research) to estimate demand for differentiated products.[12] The frequency and breadth of its application reflects its usefulness and flexibility. Nevertheless, as with any estimable demand system, it requires assumptions. We discuss some of the more relevant to our application in this section.

One feature of the logit is its similarity to a fixed effect regression in that any characteristic of client i that does not vary across choices (here, audit firms) drops out of equation (3). That is to say, equation (3) is a conditional choice probability (hence the name). Suppose, for example, that there was a direct effect of a client firm's assets on its utility—10 utils per unit of logged assets, just to be specific. Larger client firms would then receive higher utility from hiring an audit firm. However, because any such effect would add the same amount of utils to the client's utility for all five of the potential audit firms, it would not affect the ordering of the utilities each audit firm would deliver to the client. Because the utility ordering would not be affected, the client's choice would not be affected either. However, as we discussed above, the *interactions* of client characteristics like assets (or segments, foreign sales, etc.) and audit firm fixed effects can matter, because they obviously do vary across potential audit firm choices for a given client firm. These interactions serve to allow client firms with differing characteristics (larger/smaller, domestic/foreign focus, etc.) to value various audit firms' services differentially.

relationships are not available in our data. Similarly, we are unable to observe audit partners, whose rotation across clients could affect both prices and client substitution patterns.

[12] For a discussion, see Train [2009]. For an example of a specific application, see Petrin [2002].

TABLE 4

Relative Market Shares Before and After the Disappearance of Arthur Andersen

	E&Y/ Deloitte	E&Y/ KPMG	E&Y/ PwC	Deloitte/ KPMG	Deloiitte/ PwC	KPMG/ PwC
2001	1.52	1.26	1.00	0.83	0.66	0.80
2003	1.43	1.20	1.08	0.84	0.75	0.90

This table presents the relative market shares of the Big 4 audit firms for 2001 and 2003, which are the years before and after the disappearance of Arthur Andersen.

Another feature of the logit model is that it imposes the independence of irrelevant alternatives ("IIA") property, because of the assumption that the ϵ_{ij} draws are independently and identically distributed. The IIA property imposes a particular and sometimes unrealistic structure on buyers' substitution patterns. Namely, for any two potential choices x and y, the relative probability of a buyer choosing x over y does not change as alternative choices are added to or removed from the buyer's choice set. (This is sometimes described using the classic "Red Bus, Blue Bus" example.) This feature is relevant to our analysis because both of our counterfactual scenarios below (one where a Big 4 audit firm exits the market, and the other where mandated audit firm rotation forbids a firm from hiring its former audit firm) involve removing an audit firm from a client firm's choice set.

We take several steps to address this potential issue. First, we saturate the model with interactions between client characteristics and audit firm fixed effects. As discussed by Ackerberg et al. [2007], such interactions effectively allow the estimated coefficients to approach being specific to each client firm, thereby allowing for rich substitution patterns driven by the observable components of utility and reducing the influence of the constant-relative-probability property of the ϵ_{ij} component. To further allow for more complex substitution patterns, we allow the audit firm brand effects δ_{ij} to be normally distributed at the client level. These random coefficients capture persistent preferences for audit firms that are not explained by observables.

Second, the implosion of Arthur Andersen in 2002 due to its post-Enron conviction (later overturned, though too late to revive Arthur Andersen as an auditing firm) provides a unique opportunity to see if relative choice probabilities remained constant after Andersen's exit. A strong version of the IIA property implies that the relative market shares of the remaining audit firms should not change after Arthur Andersen leaves the market. Table 4 shows the six pairwise relative share ratios of the Big 4 in 2001 and 2003, before and after Andersen's exit. While the predicted invariance of the relative market shares does not hold exactly, the data are not far off. Across the six ratios, the average absolute change from 2001 to 2003 is only about 8%, and the maximum 14%. While we of course cannot guarantee that substitution patterns in a hypothetical future exit scenario would abide this closely to IIA, these results at least assuage concerns about the influence the assumption might have on our results.

Third, as shown in the appendix, we test our demand model's ability to predict actual substitution patterns out of sample by using it to predict which audit firm former Andersen clients chose in 2002, after Arthur Andersen's collapse forced them to choose a new audit firm. The model performs quite well.

Another possible limitation of our framework comes from the fact that, as mentioned above, it models the clients firms' choice of auditor as a repeated yearly decision. While this reflects the structure of the legal mandate imposed on the decision, it abstracts from more complex dynamic considerations that might be present. For example, switching costs arising from the development of client-auditor relationship capital (recall that contractual switching costs are forbidden) could cause client firms to look beyond just the upcoming year when deciding which auditor to hire. As noted, to account for the influence of these kinds of considerations on choices, we allow utility to be differentially affected by both the existence and the length of a client firm's relationship with its current auditor. Nevertheless, this is a shorthand for a more fully specified dynamic choice model.[13]

2.2 ESTIMATION

This discrete choice framework can be taken to the data by making assumptions about the distribution of the unobservable utility component ϵ_{ij}. To see how, note that equation (1) can be written as $U_{ij} = V_{ij} + \epsilon_{ij}$, where $V_{ij} \equiv \beta_j x_{ij} - \alpha \ln(p_{ij}) + \delta_{ij}$ is the portion of utility tied to observables, and ϵ_{ij} is the unobserved component. If we assume that ϵ_{ij} is distributed type 1 extreme value, the probability that client i chooses audit firm j is:

$$P_{ij} = \int \left(\frac{e^{V_{ij}}}{\Sigma_j e^{V_{ij}}} \right) f(\delta)\, d\delta, \tag{3}$$

with the integration over the normally distributed brand effects δ_{ij}. We can then use this expression to find values for the utility/preference parameters that best match client firms' choices as predicted by the model to those we observe in the data.

[13] Dynamic discrete choice models are sometimes used in the economics and marketing literatures. Our decision to use a static model (augmented with utility components tied to existing client-auditor relationships) is driven by considerations of matching the legal structure of auditor hiring, parsimony of the analytical framework, and practical considerations about the technical difficulties associated with dynamic models. We note that one of the major uses of dynamic choice models in the economics and marketing literatures is to account for the value of waiting (a buyer might rationally forgo a choice in one period to gain more information before making a choice in a future period), which does not apply in our setting due to the mandated nature of demand. We also note that our augmented static model fits the data quite well, including being able to pick up the more dynamic components of the choice setting, like the influence of ongoing client-auditor relationships.

Given the form of the choice probabilities (3), estimation is straightforward. If $y_{ij} = 1$ represents that client i chooses audit firm j and zero otherwise, then the log likelihood corresponding to (3) is:

$$LL(\alpha, \beta_j, \delta_{ij}) = \sum_i \sum_j y_{ij} \ln P_{ij} = \sum_i \sum_j y_{ij} \ln \int \left(\frac{e^{V_{ij}}}{\Sigma_j e^{V_{ij}}} \right) f(\delta)\, d\delta. \quad (4)$$

We maximize this log likelihood to estimate the utility/preference parameters α, β_j, and δ_{ij}.

2.3 PRICES

The price/fee term of equation (1) raises several estimation issues.

2.3.1. Price Endogeneity. A major concern in most demand estimation settings is the possibility of price endogeneity (i.e., $\text{cov}(p_{ij}, \epsilon_{ij}) \neq 0$). For example, if price is positively correlated with unobserved audit quality—say because client firms have a greater willingness to pay for higher quality but more costly audits—then the coefficient on price will be positively biased (toward zero, given that theory predicts the coefficient should be negative). The resulting demand estimates would make it appear that firms are less sensitive to audit fees (holding quality fixed) than they really are.

A way to avoid this bias is to identify firms' price sensitivity using fee variation that is driven by supply-side factors that are uncorrelated with any demand shifts in ϵ_{ij}. We are fortunate to have in our market setting and data a supply shifter that we can use to aid in this identification. It uses the change in supply structure induced by the sudden and unexpected exit of Arthur Andersen from the market.

The collapse of Arthur Andersen in 2002 was plausibly an exogenous shock to supply in the audit market. It reduced competition among audit firms, creating an opportunity for the remaining suppliers to increase their audit fees. Prior research on audit firm specialization (e.g., Craswell, Francis, and Taylor [1995], Hogan and Jeter [1999], Casterella et al. [2004]) implies this supply shock was industry specific: the supply shift was larger in industries where Andersen had a greater share of the audit market before its collapse (in terms of Andersen's client firms' share of industry assets). This across-industry variation is useful because, while one might be concerned that Andersen's collapse might be intertemporally linked with changes in the overall demand for auditing services (due to the passage of Sarbanes-Oxley, for example), it is unlikely that these demand shifts would be systematically related to Andersen's prior share of the industry market. In other words, there is no reason to think that industries where Andersen had larger shares of the audit business experienced systematically greater increases in demand for audit services. Thus, the cross-industry variation in Andersen's precollapse share offers a source of supply-driven price variation that is likely orthogonal to shifts in auditing demand.

To empirically validate the disappearance of Arthur Andersen as relevant to observed changes in audit fees, table 5 presents results of regressing

TABLE 5

Validation of Arthur Andersen Supply Shifter

Panel A: All firms	2002	2003	2004	2005	2006	2007	2008	2009	2010
Andersen's Industry Share in 2001	0.181***	0.150*	0.188	0.299**	0.311**	0.263*	0.269*	0.255**	0.228**
	(0.064)	(0.090)	(0.115)	(0.121)	(0.135)	(0.140)	(0.138)	(0.114)	(0.102)
Andersen Client in 2001	0.064***	0.236***	0.536***	0.465***	0.434***	0.388***	0.346***	0.283***	0.260***
	(0.024)	(0.035)	(0.035)	(0.034)	(0.039)	(0.032)	(0.034)	(0.035)	(0.042)
E&Y Client in 2001	0.114***	0.256***	0.480***	0.444***	0.413***	0.358***	0.334***	0.257***	0.234***
	(0.016)	(0.021)	(0.030)	(0.028)	(0.032)	(0.032)	(0.034)	(0.034)	(0.036)
Deloitte Client in 2001	0.083***	0.147***	0.330***	0.373***	0.342***	0.339***	0.288***	0.208***	0.197***
	(0.015)	(0.025)	(0.033)	(0.029)	(0.034)	(0.037)	(0.037)	(0.036)	(0.041)
KPMG Client in 2001	0.087***	0.170***	0.445***	0.413***	0.374***	0.343***	0.293***	0.196***	0.218***
	(0.020)	(0.030)	(0.033)	(0.036)	(0.039)	(0.040)	(0.043)	(0.047)	(0.054)
PwC Client in 2001	0.093***	0.185***	0.514***	0.490***	0.460***	0.362***	0.346***	0.271***	0.255***
	(0.017)	(0.021)	(0.031)	(0.029)	(0.032)	(0.038)	(0.035)	(0.033)	(0.037)
Change in *Ln(Assets)*	0.268***	0.345***	0.443***	0.435***	0.405***	0.408***	0.386***	0.396***	0.409***
	(0.027)	(0.022)	(0.021)	(0.025)	(0.020)	(0.026)	(0.026)	(0.021)	(0.018)
Constant	0.096***	0.212***	0.444***	0.564***	0.655***	0.720***	0.776***	0.792***	0.767***
	(0.014)	(0.022)	(0.032)	(0.035)	(0.038)	(0.046)	(0.046)	(0.035)	(0.026)
Observations	4,797	4,504	4,176	3,843	3,503	3,099	2,806	2,612	2,399
Adj. R^2	0.048	0.116	0.184	0.210	0.217	0.252	0.249	0.273	0.298

(*Continued*)

TABLE 5—*Continued*

Panel B: Not an Arthur Andersen client in 2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Andersen's Industry Share in 2001	0.114**	0.155*	0.224*	0.291**	0.330**	0.285**	0.324**	0.309***	0.275***
	(0.052)	(0.079)	(0.119)	(0.124)	(0.135)	(0.145)	(0.147)	(0.118)	(0.103)
E&Y Client in 2001	0.117***	0.256***	0.479***	0.446***	0.412***	0.358***	0.334***	0.257***	0.234***
	(0.017)	(0.021)	(0.030)	(0.028)	(0.032)	(0.032)	(0.034)	(0.034)	(0.036)
Deloitte Client in 2001	0.086***	0.147***	0.328***	0.374***	0.342***	0.339***	0.287***	0.207***	0.197***
	(0.015)	(0.025)	(0.033)	(0.029)	(0.034)	(0.036)	(0.037)	(0.036)	(0.041)
KPMG Client in 2001	0.089***	0.170***	0.445***	0.414***	0.374***	0.343***	0.293***	0.196***	0.218***
	(0.020)	(0.030)	(0.033)	(0.036)	(0.039)	(0.040)	(0.044)	(0.047)	(0.054)
PwC Client in 2001	0.096***	0.185***	0.513***	0.491***	0.459***	0.362***	0.345***	0.271***	0.254***
	(0.017)	(0.021)	(0.031)	(0.029)	(0.032)	(0.037)	(0.034)	(0.033)	(0.037)
Change in *Ln(Assets)*	0.285***	0.348***	0.444***	0.442***	0.407***	0.413***	0.389***	0.403***	0.417***
	(0.026)	(0.019)	(0.022)	(0.026)	(0.020)	(0.025)	(0.027)	(0.023)	(0.020)
Constant	0.102***	0.211***	0.440***	0.562***	0.652***	0.714***	0.767***	0.781***	0.756***
	(0.014)	(0.021)	(0.031)	(0.036)	(0.037)	(0.045)	(0.045)	(0.033)	(0.027)
Observations	4,015	3,764	3,485	3,207	2,914	2,585	2,332	2,169	1,987
Adj. R^2	0.063	0.126	0.187	0.219	0.222	0.255	0.250	0.279	0.303

This table presents regressions that validate the use of the disappearance of Arthur Andersen as a supply shifter. The dependent variable in all of the regressions is the log growth in audit fees from 2001 to the relevant year. The supply shifter is Arthur Andersen's share of the industry in 2001, with industries based on three-digit SIC codes. We also include indicator variables for the client's audit firm in 2001 along with the log growth in the client's total asset from 2001 to the relevant year. Standard errors are in parentheses and clustered at the three-digit SIC level. Panel A presents results for all firms and panel B presents results for firms that were not clients of Arthur Andersen in 2001.

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

post-2001 growth in client firms' logged audit fees on Andersen's 2001 market share in the firms' respective three-digit SIC industries, *Andersen's Share*. If our argument that Andersen's collapse is an inward shift in audit supply is correct, the coefficient on *Andersen's Share* will be positive. That is, publicly traded firms in industries where Andersen was more dominant before its collapse will see greater increases in fees afterward, regardless of whether they were Andersen clients themselves.

We estimate these fee growth regressions separately for 2002–2010. To account for any systematic differences in fee growth tied to the client's audit firm, we include as additional controls indicator variables for the firm's auditor in 2001. We include the audit firm indicator variables to control for the possibility that the fee growth experienced by Andersen clients in 2001 differed from that for firms that were clients of the other audit firms at that time. We also control for the change in the client's logged total assets over each period, as previous research indicates total assets are the most important predictor of audit fees (Hay, Knechel, and Wong [2006]). We cluster the standard errors by three-digit SIC. Because we require that the data be available over each change interval, the sample size drops monotonically from 4,797 clients for the 2001–2002 regression to 2,399 clients for 2001–2010.

The results are presented in panel A of table 5. The coefficient on the supply shifter *Andersen's Share* is indeed positive and statistically significant at every horizon except for one. Industries in which Andersen had a larger market share before its collapse did in fact experience greater growth in audit fees afterward, and this effect persisted at least through 2010.

Andersen's prominence in an industry in 2001 therefore predicts variations in audit fees throughout the following decade. However, as noted above, to obtain unbiased estimates of clients' sensitivities to fees α, it must also be the case that *Andersen's Share* is uncorrelated with demand ϵ_{ij}. If Andersen's prominence was for any reason systematically related to shifts in audit demand among clients in that industry, this would invalidate our identification strategy. While exogeneity from unobserved demand shifts in ϵ_{ij} is inherently untestable by construction, we develop evidence to further validate *Andersen's Share* as an exclusively supply-side influence on audit fees.

We first reestimated the regressions presented in panel A while replacing *Andersen's Share* with each of the Big 4's industry share in 2001 as well as the total industry share of the Big 4 in 2001. For none of these alternative shares do we find similar results in terms of either magnitude or statistical significance.

Next, we consider an alternative explanation for the results in table 5. Suppose that, when it operated, Arthur Andersen charged lower prices and provided lower quality audits. This would lead to greater increases in audit fees for Andersen clients after its exit from the market. We do not believe that this explains the results presented in table 5 for two reasons. First, Cahan, Zhang, and Veenman [2011] find that, prior to the Enron

scandal, Arthur Andersen provided audits of similar quality to those of the other major audit firms. Second and more directly, as seen in panel B, we find similar effects if we limit the sample to firms that were not Andersen clients.

Another potential alternative is that industries in which Arthur Andersen had large market shares were perceived after Enron as riskier in terms of audit quality, and audit fees rose more as a result. If this were the case, however, future accounting restatements should be higher in industries in which Andersen had a larger share. We find no evidence of this. Using data for all accounting restatements for 2002–2011 from Audit Analytics, we test whether the likelihood of a firm ever making an accounting restatement in an industry between 2002 and 2011 is correlated with Andersen's 2001 market share in the firm's industry. The results for these logistic regressions are presented in table 6. In column (1), we include only Andersen's 2001 industry share as an independent variable, and in column (2) we include client characteristics as of 2002. In both specifications, the coefficient on the Andersen's industry share is statistically insignificant. Moreover, the coefficients are economically small. The regression with controls implies that, even moving across the full range of possible values for Andersen's share (i.e., from 0 to 1), the expected increase in the probability of restatement is only 0.2%. This is an order of magnitude smaller than the average probability in the data, 2.5%.

The results in tables 5 and 6 boost confidence that *Andersen's Share* creates audit fee variation due to supply shocks that are uncorrelated with clients' relative demand for surviving audit firms, allowing us to obtain unbiased estimates of the sensitivity to fee changes of client firms' audit firm choices.

One limitation of the Andersen supply shifter is that it does not vary by year. In untabulated analysis, we use an alternative supply shifter—client within-industry mergers. This approach provides an instrument that varies by year and industry. The notion behind this instrument is as follows. Because each firm only needs a single auditor, a merger or acquisition involving firms with different auditors will almost inevitably result in one of the audit firms being dropped. The audit firm that loses a client will find itself with excess capacity that should put downward pressure on audit fees. Indeed, supply can also shift in this way even if both premerger client firms have the same auditor. This is because, even though the merged firm requires greater auditing, some of the auditor's overhead is duplicative and freed for other uses. This creates excess audit capacity for the merged firms' auditor and the resulting price effects. These supply shifts will be orthogonal to audit demand shocks as long as client-level mergers and acquisitions are driven by neither auditor choice nor audit fee considerations. When we use this instrument in our demand estimation, we find similar quantitative and qualitative results. However, given the possibility that mergers are driven by audit demand factors, we use the Andersen supply shifter in our main analysis.

TABLE 6

Future Restatements and Arthur Andersen's Industry Shares

	(1)	(2)
Andersen's Industry Share in 2001	0.0034	0.0022
	(0.005)	(0.005)
Ln(Assets)		0.0185
		(0.041)
Receivables to Assets		−0.0328
		(0.406)
Inventory to Assets		0.3094
		(0.658)
Return on Assets		1.2275**
		(0.607)
Loss		0.2608
		(0.248)
Percent Foreign Sales		0.3973**
		(0.202)
Ln(Segments)		0.1033
		(0.093)
Accelerated Filer		0.1909
		(0.249)
Going Concern Opinion		−0.2040
		(0.506)
Constant	−3.7043***	−4.2775***
	(0.127)	(0.328)
Observations	6,184	6,174
p-Value	0.499	0.001
Pseudo R^2	0.001	0.012

This table presents results from a logistic regression in which the dependent variable is coded as one if the client restates its accounting performance anytime from 2002 through 2011. We identify restatements from the Audit Analytics database. We include Arthur Andersen's share of the industry, is based on three-digit SIC as of 2001. All other independent variables are measured as of 2002. *Ln(Assets)* is the natural logarithm of the client's total assets. *Receivables to Assets* is the ratio the client's receivables to total assets. *Inventory to Assets* is the ratio of the client's inventory to total assets. *Return on Assets* is the client's return on assets measured as net income to total assets. *Loss* is an indicator for whether the client generated an accounting loss. *Percent Foreign Sales* is the ratio of the client's foreign sales to total sales. *Ln(Segments)* is the natural logarithm of the number of industrial segments of the client. *Accelerated Filer* is an indicator variable for whether the client is designated as an accelerated filer by the Securities and Exchange Commission. *Going Concern Opinion* is an indicator for whether the client received a going concern opinion from its audit firm. Standard errors clustered at the industry level are in parentheses.

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

2.3.2. Missing Fees. Another price-related issue in estimating equation (1) is that we only observe prices (audit fees) for actual matches between clients and audit firms. This is an unusual situation in demand estimation settings; researchers typically can observe the prices of each item of the available choice set. We must therefore estimate what fees a client would have expected to pay had it hired an audit firm other than the one it ended up choosing. Fortunately, in the audit setting, client characteristics explain a large portion of the variation in fees, so we can obtain sharp predictions of these unobserved fees.

We implement these "what if" prices using a predictive model estimated from the relationships between fees in observed client-audit firm matches

TABLE 7
Demand Estimation

Panel A: Demand estimates

	Coefficient	Std. Err.	*Z*-statistic	*p*-coefficient	*p*-Big 4
Ln(Predicted fees)	−2.559	0.075	−34.010	0.000	
E&Y Ln(Assets)*	0.594	0.029	20.560	0.000	
Deloitte Ln(Assets)*	0.560	0.030	18.840	0.000	
KPMG Ln(Assets)*	0.533	0.031	16.970	0.000	
PwC Ln(Assets)*	0.648	0.029	22.230	0.000	0.006
E&Y Ln(Segments)*	0.000	0.061	0.000	0.999	
Deloitte Ln(Segments)*	0.079	0.063	1.250	0.211	
KPMG Ln(Segments)*	0.047	0.064	0.730	0.462	
PwC Ln(Segments)*	−0.033	0.063	−0.520	0.604	0.409
E&Y Foreign Sales*	0.335	0.113	2.970	0.003	
Deloitte Foreign Sales*	0.370	0.129	2.850	0.004	
KPMG Foreign Sales*	0.585	0.128	4.570	0.000	
PwC Foreign Sales*	0.744	0.123	6.060	0.000	0.009
E&Y Debt*	−0.181	0.177	−1.020	0.307	
Deloitte Debt*	0.199	0.189	1.050	0.293	
KPMG Debt*	0.309	0.193	1.600	0.109	
PwC Debt*	−0.127	0.201	−0.630	0.526	0.103
E&Y ROA*	−0.580	0.195	−2.970	0.003	
Deloitte ROA*	0.262	0.224	1.170	0.244	
KPMG ROA*	−0.376	0.231	−1.630	0.104	
PwC ROA*	−0.213	0.215	−0.990	0.320	0.023
E&Y Inventory + Receivables*	−1.854	0.284	−6.530	0.000	
Deloitte Inventory + Receivables*	−1.038	0.343	−3.030	0.002	
KPMG Inventory + Receivables*	−1.386	0.296	−4.690	0.000	
PwC Inventory + Receivables*	−1.972	0.297	−6.650	0.000	0.059
E&Y Payables*	−1.522	0.357	−4.260	0.000	
Deloitte Payables*	−1.889	0.388	−4.870	0.000	
KPMG Payables*	−1.115	0.331	−3.370	0.001	
PwC Payables*	−1.352	0.345	−3.920	0.000	0.375
E&Y Ln(Years Client)*	0.481	0.083	5.800	0.000	
Deloitte Ln(Years Client)*	0.534	0.086	6.200	0.000	
KPMG Ln(Years Client)*	0.478	0.088	5.470	0.000	
PwC Ln(Years Client)*	0.624	0.085	7.320	0.000	0.574
E&Y Not Prior Client*	−5.008	0.165	−30.430	0.000	
Deloitte Not Prior Client*	−4.866	0.161	−30.270	0.000	
KPMG Not Prior Client*	−5.387	0.167	−32.200	0.000	
PwC Not Prior Client*	−4.767	0.176	−27.070	0.000	0.051
E&Y Office in MSA*	0.312	0.172	1.820	0.069	
Deloitte Office in MSA*	0.406	0.184	2.210	0.027	
KPMG Office in MSA*	0.884	0.195	4.550	0.000	
PwC Office in MSA*	0.431	0.196	2.200	0.028	0.130
E&Y Consumer Nondurables*	−0.137	0.234	−0.580	0.559	
Deloitte Consumer Nondurables*	−0.177	0.254	−0.690	0.487	

(*Continued*)

TABLE 7—*Continued*

Panel A: Demand estimates	Coefficient	Std. Err.	Z-statistic	*p*-coefficient	*p*-Big 4
KPMG Consumer Nondurables*	0.295	0.265	1.110	0.266	
PwC Consumer Nondurables*	0.257	0.250	1.030	0.304	0.196
E&Y Consumer Durables*	0.164	0.279	0.590	0.557	
Deloitte Consumer Durables*	−0.231	0.321	−0.720	0.472	
KPMG Consumer Durables*	0.514	0.347	1.480	0.138	
PwC Consumer Durables*	0.131	0.306	0.430	0.668	0.353
E&Y Manufacturing*	−0.216	0.180	−1.200	0.230	
Deloitte Manufacturing*	−0.291	0.187	−1.550	0.120	
KPMG Manufacturing*	0.046	0.194	0.240	0.812	
PwC Manufacturing*	−0.139	0.181	−0.770	0.442	0.479
E&Y Energy*	−0.732	0.238	−3.070	0.002	
Deloitte Energy*	−1.259	0.257	−4.900	0.000	
KPMG Energy*	−0.248	0.242	−1.030	0.305	
PwC Energy*	−0.949	0.254	−3.740	0.000	0.005
E&Y Technology*	0.051	0.150	0.340	0.733	
Deloitte Technology*	0.001	0.169	0.000	0.996	
KPMG Technology*	0.187	0.164	1.140	0.254	
PwC Technology*	0.006	0.163	0.030	0.972	0.748
E&Y Telecommunications*	−0.121	0.270	−0.450	0.654	
Deloitte Telecommunications*	−0.435	0.276	−1.570	0.116	
KPMG Telecommunications*	0.575	0.304	1.890	0.059	
PwC Telecommunications*	0.014	0.283	0.050	0.962	0.015
E&Y Wholesale + Retail*	0.332	0.201	1.660	0.098	
Deloitte Wholesale + Retail*	0.494	0.206	2.400	0.017	
KPMG Wholesale + Retail*	0.682	0.226	3.030	0.002	
PwC Wholesale + Retail*	0.109	0.217	0.500	0.616	0.103
E&Y Healthcare*	0.662	0.177	3.740	0.000	
Deloitte Healthcare*	−0.298	0.202	−1.470	0.141	
KPMG Healthcare*	−0.270	0.207	−1.310	0.191	
PwC Healthcare*	0.421	0.197	2.140	0.032	0.000
E&Y Utilities*	−1.809	0.420	−4.300	0.000	
Deloitte Utilities*	−0.064	0.357	−0.180	0.858	
KPMG Utilities*	−1.335	0.419	−3.180	0.001	
PwC Utilities*	−0.399	0.344	−1.160	0.246	0.000
Mean					
E&Y	1.766	0.261	6.770	0.000	
Deloitte	1.304	0.275	4.740	0.000	
KPMG	1.535	0.270	5.700	0.000	
PwC	1.015	0.283	3.590	0.000	0.126
Standard deviation					
E&Y	1.911	0.065	29.380	0.000	
Deloitte	1.855	0.079	23.380	0.000	

(*Continued*)

TABLE 7—*Continued*

Panel A: Demand estimates

	Coefficient	Std. Err.	*Z*-statistic	*p*-coefficient	*p*-Big 4
KPMG	1.881	0.081	23.300	0.000	
PwC	1.755	0.076	23.120	0.000	
Observations	251,266				

Panel B: Distribution of price elasticities for all clients

	Mean	*SD*	Q1	Median	Q3
E&Y	−1.999	0.871	−2.521	−2.463	−2.034
Deloitte	−2.169	0.741	−2.535	−2.501	−2.337
KPMG	−2.137	0.774	−2.533	−2.495	−2.301
PwC	−2.097	0.828	−2.538	−2.501	−2.275
Non–Big 4	−1.827	0.929	−2.523	−2.389	−1.075

Panel C: Distribution of price elasticities conditional on being a client of the audit firm in the prior year

	Mean	*SD*	Q1	Median	Q3
E&Y	−0.274	0.231	−0.333	−0.209	−0.130
Deloitte	−0.370	0.306	−0.460	−0.279	−0.177
KPMG	−0.338	0.262	−0.429	−0.264	−0.164
PwC	−0.297	0.277	−0.364	−0.211	−0.127
Non–Big 4	−0.527	0.596	−0.771	−0.276	−0.085

This table presents estimates of demand and price elasticity for SEC registrants over the period 2002–2010. Panel A presents annual estimates of the demand for the Big 4 audit firms. The regressions are estimated using mixed logit with the outside good being the non–Big 4 audit firms. *Ln(Predicted Fees)* is the natural logarithm of predicted fees for each of the Big 4 audit firms. *E&Y, Deloitte, KPMG*, and *PwC* are brand fixed effects for each of the Big 4 audit firms, which we allow to be normally distributed. *Ln(Assets)* is the natural logarithm of the client's total assets, *Ln(Segments)* is the natural logarithm of the client's industrial segments, *Foreign Sales* is the percentage of the clients sales generated outside of the United States, *Debt* is the ratio of short- and long-term debt to total assets for the client, *ROA* is the client's return on assets, *Inventory + Receivables* is the client's ratio of inventory and receivables to total assets, and *Payables* is the ratio of the client's account payables to total assets. *Ln(Years Client)* is the number of years that the SEC registrant has been a client of the audit firm, and *Not Prior Client* is an indicator variable for whether the SEC registrant was not a client of the audit firm in the prior three years. *Office in MSA* is an indicator coded to one if the audit firm has an office in the client's MSA and not all four of the Big 4 audit firms have an office in the MSA, and zero otherwise. Also included are interactions between the brand fixed effects at indicators for the Fama-French 10-industry classification. The column *p*-coefficient tests whether the coefficient is significantly different from zero, which represents a test of whether it differs from the preferences for the non–Big 4. The column *p*-Big 4 tests whether the coefficients for the interactions among the Big 4 are significantly different from each other. Panel B presents the distributions of own price elasticity estimates by audit firm for all clients. Panel C presents the distributions of own price elasticity estimates by audit firm conditional on being a client of the audit firm in the prior year.

and client-, auditor-, and match-specific characteristics. We considered several prediction methods including ordinary least squares, lasso regression, ridge regression, partial least squares, and two regression tree approaches (recursive partitioning and randomForest).[14] On an auditor-year basis, we use the following set of predictor variables: total assets, the number of industrial segments the firm operates in, foreign sales, debt, return on assets, inventory plus receivables, indicators to capture whether and for how long the firm was a client of the audit firm (all of the preceding are

[14] For a discussion of these methods, see Hastie, Tibshirani, and Friedman [2009].

TABLE 8
Model Fit

		Highest Predicted Probability					
		E&Y	Deloitte	KPMG	PwC	Non-Big 4	Total
Actual choice	E&Y	9,685	112	110	161	802	10,870
		89.1%	*1.0%*	*1.0%*	*1.5%*	*7.4%*	
	Deloitte	193	6,673	68	154	646	7,734
		2.5%	*86.3%*	*0.9%*	*2.0%*	*8.4%*	
	KPMG	172	108	7,274	109	673	8,336
		2.1%	*1.3%*	*87.3%*	*1.3%*	*8.1%*	
	PwC	192	114	66	8,177	579	9,128
		2.1%	*1.3%*	*0.7%*	*89.6%*	*6.3%*	
	Non-Big 4	534	243	240	274	13,056	14,347
		3.7%	*1.7%*	*1.7%*	*1.9%*	*91.0%*	
	Total	10,776	7,250	7,758	8,875	15,756	

This table compares actual audit firm choices with the predicted choices based on the estimated parameters from our demand models. The predicted choice is the audit firm with the highest predicted probability for the client and the matrix pool's actual and predicted choices over 2002–2010. The percentages in italics are relative to the row totals.

characteristics of the client firm), indicators for whether the Big 4 audit firm has an office in same MSA as the client's headquarters, indicators for the Fama-French 10-industry classification, and *Andersen's Share*. These are the same variables included in our demand estimation (interacted with audit firm fixed effects and run separately by year to match the auditor-year variation in the fee prediction model) and are commonly used in reduced form regressions of audit fees (Hay, Knechel, and Wong [2006]).

Based on root mean squared error derived from fivefold cross-validation, we find that regression trees (specifically, randomForest) best predict dollar audit fees.[15] Table A.3 in the appendix compares the fit of the various predictive models. Panels A, B, and C compare the number of times each method provides the lowest RMSE for the auditor-year pair, the mean rank in terms of RMSE of each method for the auditor-year pair, and the median rank. Given that there are scale differences in fees across years, we follow Gramacy and Pantaleo [2010] in using these distributional characteristics to compare the methods. Across all auditor-year pairs, the randomForest framework has the lowest RMSE the highest number of times, the lowest average rank, and (weakly) the lowest median rank. We therefore use randomForest to predict audit fees.

Our randomForest prediction specification yields fitted values that are highly correlated with actual audit fees within the sample. The Pearson product moment correlations between actual and predicted fees by audit firm are as follows: Ernst & Young, 0.978; Deloitte, 0.959; KPMG, 0.973; PricewaterhouseCoopers, 0.971; all other audit firms, 0.964. Figure 1 plots

[15] randomForest does equally well in predicting log audit fees. We predict dollar fees because we use predicted dollar fees in estimating the changes in consumer surplus.

TABLE 9

Mandatory Audit Firm Rotation with No Supply Response

Panel A: Changes in consumer surplus if mandatory audit firm rotation is implemented (US$ in billions)

	2008	2009	2010
Four years	4.808	4.727	4.952
Five years	4.548	4.452	4.400
Six years	3.525	4.235	4.159
Seven years	3.257	3.301	3.954
Eight years	3.046	3.041	3.112
Nine years	2.842	2.838	2.882
10 years	2.642	2.654	2.682

Panel B: Firm-level expected changes in consumer surplus if mandatory audit firm rotation is implemented (US$ dollars)

	2008				2009				2010			
		Correlations with				Correlations with				Correlations with		
	Mean	Size	Fees	Tenure	Mean	Size	Fees	Tenure	Mean	Size	Fees	Tenure
Four years	888,019	0.18	0.61	0.43	932,097	0.21	0.62	0.39	988,816	0.39	0.71	0.36
Five years	839,978	0.18	0.61	0.43	877,878	0.21	0.61	0.41	878,558	0.22	0.61	0.41
Six years	651,095	0.19	0.57	0.51	835,177	0.21	0.61	0.42	830,465	0.22	0.60	0.42
Seven years	601,599	0.19	0.56	0.53	650,961	0.21	0.58	0.48	789,608	0.22	0.60	0.43
Eight years	562,681	0.17	0.54	0.55	599,776	0.21	0.56	0.50	621,308	0.21	0.57	0.48
Nine years	524,938	0.15	0.51	0.56	559,745	0.18	0.53	0.52	575,470	0.21	0.56	0.50
Ten years	488,004	0.14	0.50	0.58	523,404	0.17	0.52	0.53	535,475	0.18	0.53	0.52

The table presents expected changes in consumer surplus if mandatory audit firm rotation were to be implemented after 4 through 10 years. Estimates are based on table 7 coefficient estimates for 2008, 2009, and 2010, and are denominated in billions of U.S. dollars. For the implementation of mandatory audit firm rotation at various tenures, we remove an audit firm from the client's choice set if the length of the auditor-client relationship was equal to or greater than the specified number of years that require mandatory rotation and then estimate the expected change in consumer surplus, C_{ijm}, for each firm i. To do so, we draw vectors of type 1 extreme value error terms—one for each of the Big 4 audit firms and one for the outside good. For each vector draw, we combine in equation (1) the parameter estimates from the demand estimation along with the firm-auditor characteristics and the error term draw to calculate the utility that the client would receive from choosing each of the Big 4 audit firms and the outside good. We then pick the audit firm that leads to maximum utility under this unrestricted choice set. We next restrict the choice set for each client based on mandatory audit firm rotation and calculate the maximum utility that the client would have received under the restricted choice set. Then, we solve for the change in consumer surplus C_{ijm} that equates the maximum utilities. For each client, we repeat this procedure 1,000 times and take the average of the required dollar transfer to create $E[C_{ijm}]$. Panel A presents the estimates of the expected total change in consumer surplus for mandatory audit firm rotation. Panel B presents the firm-level mean change in consumer surplus and correlations of the firm-level change in consumer surplus with firm size, audit fees, and tenure with audit firm.

TABLE 10

Disappearance of a Big 4 Audit Firm with No Supply Response

Panel A: Total expected changes in consumer surplus if one of the Big 4 audit firms disappears (US$ in billions)

	2008	2009	2010
E&Y	1.777	1.640	1.640
Deloitte	1.472	1.391	1.377
KPMG	1.369	1.350	1.278
PwC	1.775	1.664	1.701

Panel B: Firm-level expected changes in consumer surplus if one of the Big 4 audit firms disappears (US$ dollars)

		2008				2009				2010			
			Correlations with				Correlations with				Correlations with		
	Mean	Size	Fees	Tenure	Mean	Size	Fees	Tenure		Mean	Size	Fees	Tenure
E&Y	Client	1,526,153	0.42	0.77	0.23	1,515,817	0.51	0.77	0.21	1,530,390	0.59	0.84	0.20
	Not a client	14,076	0.00	0.05	0.04	9,744	0.02	0.04	0.02	8,672	0.06	0.06	−0.01
Deloitte	Client	1,808,759	0.24	0.65	0.24	1,809,697	0.29	0.70	0.28	1,787,254	0.33	0.71	0.28
	Not a client	12,497	0.00	0.05	0.01	10,676	0.02	0.08	0.00	9,409	0.01	0.04	−0.02
KPMG	Client	1,715,318	0.36	0.70	0.16	1,741,906	0.37	0.71	0.17	1,632,545	0.48	0.75	0.18
	Not a client	7,382	0.01	0.04	−0.01	13,981	0.02	0.15	0.01	9,222	0.02	0.04	−0.01
PwC	Client	2,028,666	0.30	0.72	0.33	2,039,521	0.34	0.67	0.31	2,062,620	0.43	0.73	0.30
	Not a client	9,426	0.01	0.05	0.03	12,251	0.03	0.08	0.01	10,560	0.03	0.10	−0.01

The table presents expected changes in consumer surplus if one of the Big 4 audit firms disappeared. Estimates are based on table 7 coefficient estimates for 2008, 2009, and 2010. For the disappearance of each of the Big 4 audit firms, we estimate the expected change in consumer surplus, C_{ijm}, for each firm i. To do so, we draw vectors of type 1 extreme value error terms—one for each of the Big 4 audit firms and one for the outside good. For each vector draw, we combine in equation (1) the parameter estimates from the demand estimation along with the firm-auditor characteristics and the error term draw to calculate the utility that the client would receive from choosing each of the Big 4 audit firms and the outside good. We then pick the audit firm that leads to maximum utility under this unrestricted choice set. We next restrict the choice set for each client (i.e., remove one of the Big 4 audit firms) and calculate the maximum utility that the client would have received under the restricted choice set. Then, we solve for the change in consumer surplus C_{ijm} that equates the maximum utilities. For each client, we repeat this procedure 1,000 times and take the average of the required dollar transfer to create $E[C_{ijm}]$. Panel A presents the estimates of the expected total change in consumer surplus if each of the Big 4 disappears. Panel B presents the firm-level mean change in consumer surplus and correlations of the firm-level change in consumer surplus with firm size, audit fees, and tenure with audit firm.

TABLE 11

Semi-Elasticity of Audit Fees to Changes in Three-Digit SIC Audit Firm Market Share

Andersen's Industry Share in 2001	0.153**
	(0.062)
Ln(Assets)	0.4733***
	(0.006)
Receivables to Assets	−0.4083***
	(0.051)
Inventory to Assets	0.7668***
	(0.071)
Return on Assets	−0.3357***
	(0.053)
Loss	0.1780***
	(0.025)
Percent Foreign Sales	0.5504***
	(0.022)
Ln(Segments)	0.2156***
	(0.011)
Accelerated Filer	−0.1614***
	(0.025)
Going Concern Opinion	0.1978***
	(0.048)
Constant	9.3935***
	(0.044)
Observations	6,174
Adjusted R^2	0.707
Auditor fixed effects	Yes

This table presents ordinary least squares estimates of the semi-elasticity of audit fees in 2002 to Andersen's share of three-digit SIC industry assets in 2001. The dependent variable is the natural logarithm of audit fees in 2002. Andersen's industry share is measured as of 2001, while the remaining independent variables are measured contemporaneously with audit fees. *Ln(Assets)* is the natural logarithm of the client's total assets. *Receivables to Assets* is the ratio of the client's receivables to total assets. *Inventory to Assets* is the ratio of the client's inventory to total assets. *Return on Assets* is the client's return on assets measured as net income to total assets. *Loss* is an indicator for whether the client generated an accounting loss. *Percent Foreign Sales* is the ratio of the client's foreign sales to total sales. *Ln(Segments)* is the natural logarithm of the number of industrial segments of the the client. *Accelerated Filer* is an indicator variable for whether the client is designated as an accelerated filer by the Securities and Exchange Commission. *Going Concern Opinion* is an indicator for whether the client received a going concern opinion from its audit firm.

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

predicted versus actual log audit fees for our sample. The model does well in the mass of the distribution and less well in the tails.

To further evaluate the randomForest prediction specification, we compared actual versus predicted fees in 2002 for Arthur Andersen clients. The benefit of this comparison is that the Andersen clients chose new audit firms in 2002 and the predictions are therefore not based on historical data about the match between the client and the audit firm. The Pearson product moment correlations between actual and predicted fees for the Andersen clients are as follows: Ernst & Young, 0.960; Deloitte, 0.962; KPMG, 0.981; PricewaterhouseCoopers, 0.934; all other audit firms, 0.816. Figure 2 plots predicted versus actual log audit fees for our sample. Again, the model does well in predicting the mass of the distribution.

TABLE 12

Supply Responses for Counterfactuals

Panel A: Supply response for the implementation of mandatory audit firm rotation (US$ in billions)

	2008	2009	2010
Four years	1.321	1.220	1.327
Five years	1.282	1.169	1.158
Six years	1.044	1.134	1.114
Seven years	0.982	0.911	1.083
Eight years	0.894	0.855	0.879
Nine years	0.832	0.776	0.826
10 years	0.778	0.731	0.750

Panel B: Supply response for the disappearance of a Big 4 audit firm (US$ in billions)

	2008	2009	2010
E&Y	0.473	0.426	0.421
Deloitte	0.431	0.361	0.356
KPMG	0.439	0.386	0.386
PwC	0.576	0.544	0.530

This table presents estimates of the increase in total annual audit fees under the two counterfactuals. To calculate the expected supply-side responses, we estimate the semi-elasticity of audit fees in 2002 with respect to the percent share of industry total assets audited by Arthur Andersen in 2001 based on three-digit SIC. These estimates are presented in table 11. The estimated semi-elasticity is a 0.15% increase in audit fees for each one percentage point of total industry assets audited by Arthur Andersen. For each counterfactual, we calculate by three-digit SIC the percentage of total assets either audited by the firm subject to mandatory rotation or the disappearing Big 4 audit firm. For each client, we then calculate the expected increase in annual audit fees based on the client's actual audit fees times the semi-elasticity times the percentage of industry assets audited by the rotating or disappearing firm. The columns present sums by year denominated in billions of US$. Panel A presents the supply response for the implementation of mandatory audit firm rotation. Panel B presents the supply response if one of the Big 4 audit firms disappears.

In section 2.3.1, we validated the Andersen supply shifter using ordinary least squares. To ensure that the Andersen supply shifter performs well in the nonlinear randomForest prediction specification, we implement a five-fold cross-validation that compares fee predictions that do and do not include the Andersen supply shifter. (We carry out this analysis because, unlike ordinary least squares, randomForest does not provide interpretable coefficient tests.) Specifically, for each auditor-year pair, we generate differences between the root squared errors of the two prediction specifications using 100 repetitions of fivefold cross validations. We then test whether the distribution of the differences was significantly greater than zero. To calculate the differences, we subtract the root squared error of the specification that includes the Andersen shifter from the root squared error that excludes the shifter so that positive *t*-values represent that the shifter improves the prediction model. Table A.4 of the appendix presents the results from this analysis. Consistent with the results presented in table 5, the Andersen supply shifter significantly improves the predictive ability of the randomForest model each year for the Big 4 firms and for seven of the nine years for the non–Big 4 firms.

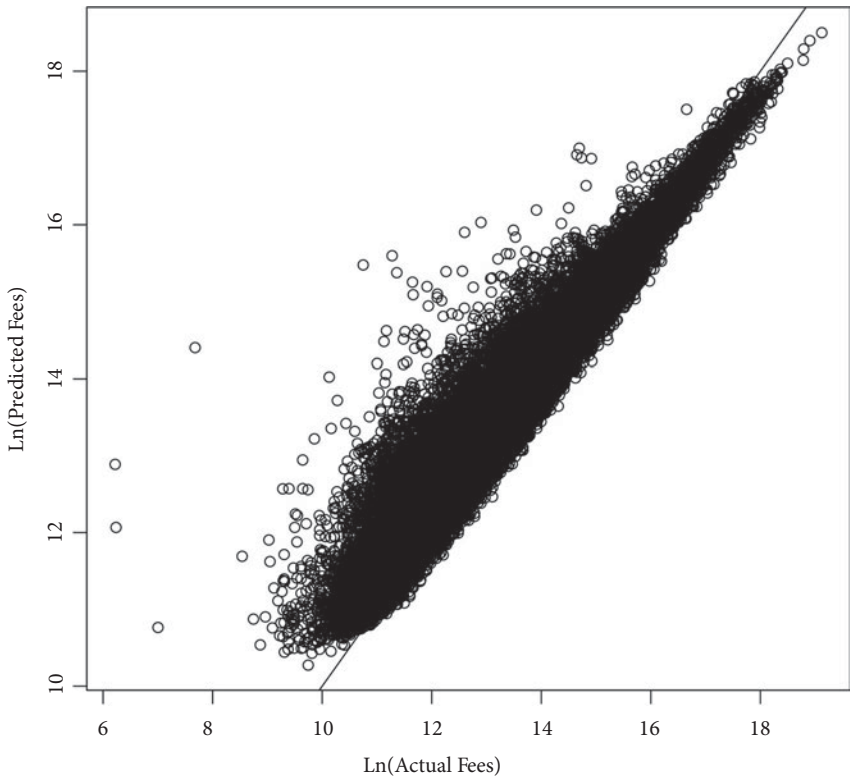

FIG. 1.—Actual versus predicted fees. This figure plots predicted versus actual log audit fees. Predicted fees are generated on an auditor-year basis using randomForest with the following predictor variables: total assets, the number of industrial segments the firm operates in, foreign sales, debt, return on assets, inventory & receivables, indicators to capture whether and for how long the firm was a client of the audit firm (all of the preceding are characteristics of the client firm), indicators for whether the audit firm has an office in the client's MSA, and indicators for the Fama-French 10-industry classification. In addition, we include a supply shifter: Arthur Andersen's share of the client's industry (three-digit SIC) in 2001.

In our demand estimations, we use predicted fees in equation (1) for all audit firms, including the actual audit firm chosen by the client. We do so because the prices associated with actual choices may include a negative price shock that could otherwise bias our estimated price coefficients toward zero. For a discussion of this issue, see Erdem, Keane, and Sun [1999].[16]

[16] This theoretical concern aside, we find similar results in untabulated analysis if we instead use observed prices for the audit firm actually chosen by the client.

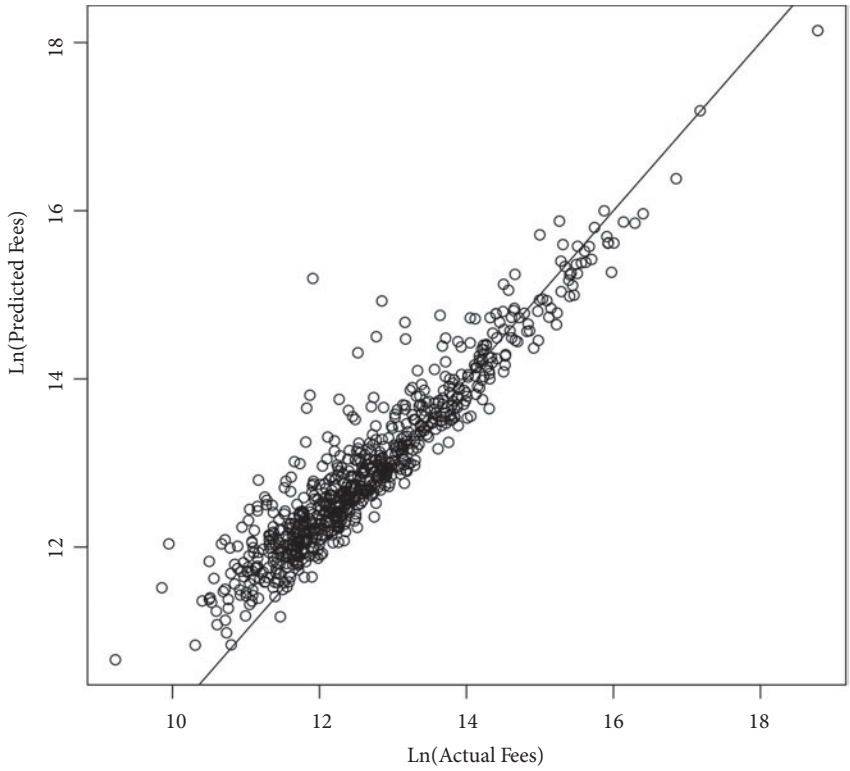

FIG. 2.—Actual versus predicted fees for Arthur Andersen clients in 2002. This figure plots predicted versus actual log audit fees for Arthur Andersen clients in 2002. Predicted fees are generated on an auditor-year basis using randomForest with the following predictor variables: total assets, the number of industrial segments the firm operates in, foreign sales, debt, return on assets, inventory & receivables, and indicators for the Fama-French 10-industry classification.

3. Demand Estimation

3.1 SAMPLE

Our sample consists of SEC registrants with available data. We obtain audit fee and restatement data from Audit Analytics, which provides fee data starting with the mandatory disclosure of audit fees in 2000. We use Compustat to obtain accounting-based financials and the histories of auditor-client matches prior to 2000 (we need this earlier match information to construct our measure of the extent of an existing auditor-client relationship).

3.2 CLIENT FIRMS' PREFERENCES OVER AUDIT FIRMS

Panel A of table 7 presents the results from estimating our benchmark demand model (1). These preference parameters form the basis for our estimates of clients' willingness to pay for audit services and willingness to

substitute among audit firms. We estimate the preference function over the period 2002–2010.

To start, it is worth discussing how to interpret the coefficient estimates presented in panel A. The brand effects for each of the Big 4 (the δ_{ij}s) reflect utility effects created by each of these audit firms. We allow these brand effects to vary across clients and capture this heterogeneity by estimating random coefficients that are normally distributed. In panel A, we report the mean and standard deviation of these coefficients. A larger estimate of the coefficient for a particular audit firm indicates that, all else equal, that audit firm is more likely to be chosen (a high coefficient implies that the audit firm delivers a high utility, all else equal). Therefore, the estimated coefficients on the brand effects reflect not just the utilities that each of the Big 4 delivers to client firms relative to a non–Big 4 choice (which, as the excluded category, can be thought of as having a dummy variable coefficient that is normalized to zero), they also reflect the utility levels that the Big 4 audit firms deliver relative to each other.

To see this in an example, let us work off the estimates presented in panel A. There, the means of all of the Big 4 dummy variables have positive coefficient estimates. This means that, all else equal, each of the Big 4 is preferred on average to a non–Big 4 audit firm (which again can be thought of as having a brand effect coefficient of zero). Within the Big 4, Ernst & Young has the largest coefficient estimate, then KPMG, then Deloitte, and finally PricewaterhouseCoopers. These differences indicate that, again all else equal, Ernst & Young is most preferred by client firms, then KPMG, then Deloitte, then PricewaterhouseCoopers (though Pricewaterhouse Coopers is still preferred to an audit firm outside the Big 4). The magnitudes of these relative preferences are given by the sizes of the coefficients, though these reflect differences in utils and would need to be converted to dollars using α. However, the p-value in the final column shows that these mean effects for the Big 4 firms are not statistically different from one another.

Note that these means reflect the *average* preference for each of the Big 4 across all client firms. The estimated standard deviations of these brand effects indicate that there is substantial dispersion in the strength of these effects. Some clients have much weaker or much stronger preferences for specific auditors than these averages. In fact, given the normality of these brand effects and the fact that their estimated standard deviations are of roughly the same magnitude as their averages, this suggests about one-third of client firms have a negative brand effect for a Big 4 auditor; in other words, again all else equal, they prefer a non–Big 4 auditor to that Big 4 firm.

An important thing to keep in mind is that everything that we have discussed to this point deals with the Big 4 main effects, divorced from any specific observable characteristics of the client firm. But in our utility specification, we also include interactions of client firms' characteristics (e.g., logged assets and segments, foreign sales, etc.) with the brand effects, which

we do not allow to be random. What these interactions allow, and what the estimated coefficients on these interactions indicate, is that clients with different characteristics value potential audit firms differentially. Again, working off the estimates in panel A as an example, the interaction between logged client assets and the Big 4 dummy variables with the largest estimated coefficient is for PricewaterhouseCoopers (0.648). This means that, as we compare across client firms of different asset levels, the relative preference for PricewaterhouseCoopers grows with client firm size faster than for the other Big 4 audit firms. Thus, while the main utility effect of PricewaterhouseCoopers might have been smaller than for the other Big 4 firms, PricewaterhouseCoopers is looked at relatively more favorably by clients with a lot of assets than those with fewer.[17] Hence, the total influence of PricewaterhouseCoopers on a client's choice is not just its main effect, but also the effect of all the interactions between that client's characteristics and the PricewaterhouseCoopers dummies. We of course compute and include all of these elements of brand—main effects and interactions—in our analysis.

Several patterns emerge across the annual estimates presented in panel A. First, client firms' audit firm choices are sensitive to audit fees. The coefficient on $ln(Audit\ fees_{ij})$ is negative and significant: −2.559. We calculate and discuss the elasticities implied by this estimate below.[18] At the same time, this sensitivity to fees is far below the extreme responsiveness (theoretically, infinite) of a nondifferentiated market, indicating that clients do not view audit firms, even those among the Big 4, as undifferentiated.

Second, for each of the Big 4 audit firms, the interactions between the audit firm fixed effects and client size are all positive and significant, implying that larger clients have a stronger preference for the Big 4.[19] Moreover, the

[17] The preference of larger firms for PricewaterhouseCoopers could be due to historical reasons. As discussed by Zeff and Fossum [1967], Price Waterhouse & Co. was the largest of the Big 8. Moreover, as discussed by Allen and McDermott [1993], Price Waterhouse & Co. was historically considered the most prestigious firm, with *Fortune* magazine praising it in 1932 as "easily the world's foremost accounting firm in size, in reputation, in number of clients."

[18] While, as noted, we focus on the post-2001 period to use exogenous variation created by the implosion of Arthur Andersen, we found negative and significant coefficients on $ln(Audit\ fees_{ij})$ in untabulated tests for 2000 and 2001. We also estimated the model using fees predicted without including the Andersen supply shifter. As theory predicts, the average point estimate on predicted fees (−2.45) was more positive (that is, smaller in magnitude) than those in table 7. The size of the difference was modest, however, and statistically insignificant. Thus, any price endogeneity due to unobservable demand shifts that existed in the market was relatively minor.

[19] To evaluate the possibility that the demand model only does well in explaining preferences for the Big 4 among large clients while doing more poorly for smaller clients that are more likely to choose the middle tier audit firms (Grant Thornton and BDO Seidman), we reestimated demand while including both Grant Thornton and BDO Seidman as separate choices (so client firms' choice set includes each of the Big 4, Grant Thornton, BDO Seidman, and the (remaining audit firms in the) outside good). Both the main specification and this

coefficients among the Big 4 are not equal, implying that the relation with size differs among the Big 4 audit firms. The rightmost column of the table reports *p*-values for tests of joint equality of the four audit firm fixed effects and their interactions with client observables. The hypothesis that clients' preferences for each of the Big 4 vary with client assets equally across each audit firm can be rejected with a *p*-value of 0.006. Similarly, client firms having a larger share of sales in foreign markets also have a stronger preference for using a Big 4 audit firm and the coefficients among the Big 4 are not equal. Big 4 firms that have an office in a client's headquarters MSA when not all other Big 4 do are also more preferred by those local clients, as reflected in the positive coefficients on the *Office in MSA* indicators.[20] Factors associated with clients having a weaker relative preference for a Big 4 auditor include high ratios of inventories and payables to sales as well as the client being in the energy industry.

Third, having hired an audit firm the previous year greatly affects the probability that a client firm rehires the audit firm, even after controlling for match-specific observables. The coefficients on the interactions of Big 4 dummies with *Not Prior Client* are negative and significant in every case. Moreover, the effect varies across the Big 4 firms. Thus, the persistence in audit firm choice discussed above reflects an unobserved match-specific attribute. Furthermore, the interactions with $ln(Years\ client_{ij})$ are positive and significant, implying that, while having a current relationship is an important determinant of audit firm choice, so is the duration of the history of this relationship. However, the effect of history of the relationship does not vary across the Big 4 firms.

We next turn to the price elasticities implied by the demand estimates—the percentage change in the probability of choosing the audit firm resulting from a 1% increase in audit fees. Here, we follow standard practice in discrete choice demand estimation by imposing that changes in price have the same impact on utility for all products (i.e., a common α). The economic logic of this standard assumption is straightforward: paying a given amount more in the form of higher prices has the same effect on the consumer's utility regardless of what choice that expenditure was put toward (this follows naturally from the notion that the opportunity cost of those expended dollars to the client firm is the same regardless of which auditor received those dollars). Note, however, that imposing a common price coefficient across all choices does not impose that price *elasticities* are the same

alternative specification do equally well in predicting the choices of clients for the Big 4 audit firms, implying that the main specification well explains preferences for the Big 4 throughout the client size distribution. To further evaluate the robustness of the estimates, we replace nonmatch prices with "what if" prices based on three years of tenure to capture any effects of low-balling. The parameter estimates for this alternative specification are similar to the main results. In addition, we replaced audit fees with total fees and again found similar results.

[20] It could be the case that client demand determines audit firms' choice of office location. We find similar qualitative and quantitative results when we exclude office locations from our demand estimates.

across all products. In fact, they are not (and only will be in the very special case where choices are observed to have the exact same market shares in the data). In logit demand systems like the one we estimate, the price elasticities are a function of both the sensitivity of utility to price changes (i.e., α) and the choice probabilities as predicted from all consumer characteristics and product attributes. This is related to the fact that price elasticities are not just about dq/dp (which is closest to α in our case), but also p/q (which in the logit demand system is a function of predicted probabilities).[21] This dependence of the price elasticity on not just α but also all the other components of the utility function explains why there are different price elasticities for each audit firm. Intuitively, the price elasticity reflects not just how much an auditor's fee increase would reduce a client firm's utility if it chose that auditor, but also how likely that client would be to choose that auditor in the absence of that fee increase. For potential clients with preferences that would make them very likely to choose the auditor in the absence of any price increase (having a very strong brand preference for that audit firm, for instance), it is unlikely that the higher fees would change their choice of the auditor. This makes the overall response to a fee increase of such clients—their price elasticity of demand for that auditor—small in magnitude. Similarly, for potential client firms that would be very *unlikely* to choose the auditor before any price increase (like those with a very weak brand preference for the auditor), higher fees are also unlikely to change their choice, and their elasticity will be small. Thus, the most responsive potential clients to a fee increase—those with the highest elasticity of demand for the audit firm—are those with intermediate likelihoods of hiring the auditor, as their choice is more likely to be shifted by a fee change. An audit firm's overall price elasticity across the entire market is the combination of all these price responses across all potential clients. Therefore, even if every potential client firm's utility is equally affected by a given fee increase, the wide and varied distribution of probabilities with which various potential clients would choose that auditor implies every auditor faces different price elasticities across individual clients and the market as a whole.

Panels B and C of table 7 present estimates of the distribution of client firms' own-price elasticities by audit firm (the values presented are averages of annual elasticity estimates over the sample). As reflected in panel B, the average price elasticities audit firms face across all potential clients are in the neighborhood of −1.8 to −2.2. An interesting contrast is observed, however, when we look at client firms' elasticities for their audit firm in the prior year, shown in panel C. These estimates, which incorporate the effect on elasticities of our current-match variables (i.e., the interactions of audit

[21] Specifically, with logit demand the change in probability of a firm i choosing audit firm j for a change in an observable factor z_{ij} is $\frac{dP_{ij}}{dz_{ij}} = \frac{dV_{ij}}{dz_{ij}} P_{ij}(1 - P_{ij})$ where V_{ij} represents the observable portion of utility and P_{ij} is the predicted probability that client i chooses audit firm j.

firm fixed effects with an indicator for the firm not being a client of the audit firm and the number of years that the client firm has been working with its current audit firm), reveal that client firms' choices are much less sensitive to changes in the fees of their current audit firms. The mean elasticity estimates for the Big 4 are around −0.27 to −0.37, an order of magnitude smaller than the average elasticities in panel B. These differences reflect the powerful effect on choices of match-specific utility components within existing client-auditor pairs. As we will see later, the forced breakup of those matches, whether due to the exit of one of the Big 4 audit firms or the imposition of mandatory audit firm rotation, can destroy a considerable amount of client firms' consumer surplus.

3.3 FIT OF THE MODEL

Our demand model fits the data quite well. Table 8 shows the correspondence between the client firms' predicted audit firm choices (i.e., the audit firm with the largest estimated mean utility for the client, V_{ij}) and their actual choices. Across each of the Big 4 audit firms, the model correctly predicts audit firm choice for at least 86% of the clients. Moreover, for clients that chose a non–Big 4 audit firm, the model-based predictions are correct in 91% of the cases. These results suggest that our specification and estimates of equation (1) qualitatively and quantitatively embody the audit firm hiring decisions of client firms.

We further tested the ability of the model to fit the data by using it to predict which audit firms were chosen in 2002 by companies that were Andersen clients in 2001. This allows us to see if the aspects of our model that are not tied to existing client-auditor relationships can still predict choices. The Andersen implosion offers an ideal experiment for this test, as it provides a set of client firms that were exogenously separated from their prior relationships with their auditor. To conduct this exercise, we first estimate our demand model using data from 2002. We estimate parameters for three samples: all client firms present that year, only those firms that were Andersen clients in the prior year, and those firms that were not Andersen clients in the prior year. The demand system coefficients are presented in panel A of appendix table A.1, and the implied average price elasticities are in panel B. Panels A–C of table A.2 show the predictions of former Andersen clients' 2002 auditor choices using each of the three variants of the demand estimates. Not surprisingly, given the empirical strength of existing client-auditor matches in predicting choices, the model's predictions for this set of separated client firms match the data less closely. Still, the model (all three versions) is systematically more likely to predict the client firms' actual choices than the alternatives. On average, across all three versions, the model predicts the actual choice in about half the cases (2.5 times the likelihood of a random prediction). The average predictive power of each set of demand parameter estimates from the three samples is roughly the same. These results indicate that, while existing client-auditor relationships are both empirically important and have high predictive power, other

aspects of clients' preferences also affect their auditor choices in a way that we can predict and measure.

4. *Counterfactuals*

Having obtained estimates of client firms' preference parameters, we next use them to address the two aforementioned policy-relevant issues: implementation of mandatory audit firm rotation and increased concentration among audit firms resulting from the exit of one of the Big 4.

To estimate the impact of these counterfactual scenarios, we use the methodology outlined by McFadden [1999]. This involves calculating the expected change in consumer surplus for each audit client firm as the expected dollar transfer required to make that client indifferent between the unrestricted choice set of the status quo and the restricted choice set arising under the counterfactuals. We then sum these estimates of lost surplus across individual clients to find the expected total change in consumer surplus.

For example, suppose that under the status quo client i chooses the audit firm j that yields maximized utility $\max_j U(Audit\ fees_{ij}, x_{ij,}\epsilon_{ij})$, and under the counterfactual client i chooses audit firm m from a restricted choice set that yields maximized utility $\max_m U(Audit\ fees_{im}, x_{im,}\epsilon_{im})$. The change in consumer surplus, C_{ijm}, is the dollar transfer (or, equivalently, the reduction in audit fees) that would be required to equate the client's maximum utility under the restricted choice set with what it obtained under the unrestricted choice set:

$$\underbrace{\max_j U(Audit\ fees_{ij}, x_{ij}, \epsilon_{ij})}_{\text{utility with unrestricted choice set}} = \underbrace{\max_m U(Audit\ fees_{im} - C_{ijm}, x_{im}, \epsilon_{im})}_{\text{utility with restricted choice set}}. \quad (5)$$

In other words, C_{ijm} is what one would need to pay client firm i to compensate it for its inability to choose audit firm j. The total change in consumer surplus for the counterfactual is the sum of C_{ijm} across client firms.

Mechanically, to estimate C_{ijm}, for each firm i we draw a vector of type 1 extreme value error terms—one for each of the Big 4 audit firms and one for the outside good. We then compute the utility that client firm i would obtain from each audit firm choice using equation (1) by combining the parameter estimates from panel A of table 7, the client firm and audit firm characteristics observed in the data, and the error term draws. The audit firm that delivers the largest utility of the five choices is then client firm i's simulated choice for that error draw. We next restrict the choice set for each client (i.e., depending on the counterfactual being estimated, remove one of the Big 4 audit firms or remove the client's prior audit firm based on tenure) and calculate the maximum utility that the client would receive under the restricted choice set. Then we solve for the C_{ijm} that equates these two maximized utilities. Given that dollar fees enter into utility in log form, C_{ijm} is simply the exponent of the difference in maximized utilities

between the unrestricted and restricted choice sets normalized by the estimated marginal willingness to pay. We repeat this procedure 1,000 times for each client firm, each time with a new error vector, and then average the lost surplus values of C_{ijm} from each simulation to compute $E[C_{ijm}]$. These values in hand, we aggregate these estimates across client firms to calculate the expected total change in consumer surplus in each counterfactual.

Computing the expected changes in consumer surplus as above using the observed audit fees in the data (or, more precisely, our estimates of audit fees given those observed in existing matches) effectively assumes that there is no supply-side response in the counterfactual scenarios. That is, it estimates the surplus lost by client firms if one of the Big 4 exits or if audit firm rotation becomes mandatory while holding the fees charged by the remaining audit firms fixed. In this sense, it estimates the pure demand-side effect of the counterfactuals. However, it seems likely that audit firms might respond in these counterfactual worlds by changing their fees. For instance, if one of the Big 4 exits, the resulting reduction in competition is likely to result in the remaining audit firms charging higher fees within any given match. We therefore estimate two changes in expected surplus for each counterfactual scenario: a pure demand-side effect that holds audit firms' fees fixed, and a second that estimates and takes into account audit firms' strategic fee setting responses in the counterfactual scenario.

4.1 INTRODUCTION OF MANDATORY AUDIT FIRM ROTATION

The first counterfactual scenario involves the implementation of mandatory audit firm rotation. To estimate the expected change in consumer surplus in this case, we calculate the dollar transfer required to make clients indifferent to the removal of their current audit firm from their choice set if the client-auditor match has lasted beyond the statutory maximum allowed. We compute separate estimates for different possible statutory maximum tenures, running from 4 through 10 years. We compute these estimates separately for 2008, 2009, and 2010 to gain a sense as to the stability of the estimated effects over time.

Panel A of table 9 presents these expected total changes in consumer surplus. The expected change is approximately $2.6 billion if rotation is mandatory after 10 years, and $4.7–5.0 billion if rotation is mandatory after 4 years. (The estimated lost surplus is larger for shorter horizons because a greater number of matches are affected.) The observed persistence of client-auditor matches reflects the value clients see in preserving existing relationships; mandatory audit firm rotation would force a loss in this value for pairs reaching the regulatory limit.

Panel B shows the average of the client-level surplus changes under mandatory audit firm rotation as well as the correlation of these surplus changes with client characteristics. As with the aggregate losses presented in panel A, the average client-level change becomes smaller as the regulatory limit increases, as more client firms are left unaffected by the mandate. If rotation is mandatory after four years, the mean expected

change in consumer surplus ranges from $888,000 to $989,000, depending upon the year the mandate would have been imposed. If rotation is mandatory after 10 years, the mean expected change in consumer surplus ranges from about $488,000 to $535,000. The expected changes in surplus also correlate with client characteristics, with the highest correlations for audit fees (correlation coefficients ranging from 0.50 to 0.71), followed by tenure with the audit firm (0.36–0.58), and then client size (0.14–0.39).

Note that, even though no audit firms exit the market in this counterfactual scenario, mandatory audit firm rotation implies an increase in market concentration. This is because the audit firm that is forced out due to rotation is necessarily removed from its formerly matched client firm's choice set. If the remaining eligible audit firms recognize that they now face less competition when negotiating over audit fees with the client firm, this may lead to higher fees. The lost surplus estimates in table 9 do not incorporate any such pricing response, focusing on only the demand-side consequences of mandatory rotation. Below, however, as we also do with the Big 4 exit counterfactual, we estimate the expected size of the supply-side audit fee (i.e., pricing) responses of the remaining competing audit firms and compute the consequences of these responses for client firms' consumer surplus.

Conceptually, these surplus estimates may in whole or in part represent agency costs. That is, they may reflect what managers are willing to pay in order to avoid switching audit firms, even if that is in opposition to the interests of shareholders. Under this interpretation, long tenures lead to a loss of audit firm independence that managers exploit for their private benefit. Prior research, however, does not provide support for the idea that audit firm independence decreases over longer tenures. In fact, several studies find that audit failures are more likely to occur during the early years of tenure (e.g., Geiger and Raghunandan [2002], Carcello and Nagy [2004]), and others find that audit quality appears to increase over audit firm tenure (e.g., Johnson, Khurana, and Reynolds [2002], Myers, Myers, and Omer [2003], Ghosh and Moon [2005], Chen, Lin, and Lin [2008]). We therefore believe that these estimates are more likely to represent losses in surplus to client firms' shareholders. Nevertheless, as we noted above, there could also be social benefits to mandating rotation. Our estimates serve to quantify the costs such mandates impose on client firms—costs that any social benefits would be weighed against in evaluating mandatory rotation policies.

We also note that these estimated surplus changes are the one-time effect of the imposition of mandatory rotation. The long-run effect of such a policy would lead to smaller but repeated losses (for example, the mandated rotation after 10 years would break up all relationships 10 years old or longer in the first year it is implemented, but would only affect relationships of that set of relationships entering their 10th year in the second year of implementation). Of course, both clients and audit firms might

respond differently within relationships in response to the implementation of mandatory rotation. They would have less incentive to build persistent client-auditor ties of any sort. This new behavior could shape client firms' preferences in different ways from those we estimate above, which of course were formed in the absence of a rotation mandate. These more complex potential dynamic responses on both sides of this market are beyond the scope of our analysis here, however.

4.2 EXIT OF A BIG 4 AUDIT FIRM

The second counterfactual involves the exit of a Big 4 audit firm. We estimate the total expected changes in consumer surplus that would be caused by the exit of each of the Big 4 audit firms (in isolation, of course). Again, we compute separate estimates for 2008, 2009, and 2010.

Panel A of table 10 presents the estimated changes in consumer surplus when audit fees are held constant—that is, without allowing for any strategic pricing response from the remaining audit firms. The estimated total changes in consumer surplus range from a loss of just under $1.3 billion from the exit of KPMG in 2010 up to a roughly $1.8 billion loss for the disappearance of Ernst & Young in 2008. These losses are substantial. Across the Big 4, the estimated consumer surplus loss from the exit of an audit firm ranges from 52% to 66% of the total audit fees client firms pay to that audit firm per year. Because of differences in the size of their audit operations, the ordering of this relative consumer surplus loss is actually inverted from the total levels; the largest losses relative to fees would occur if KPMG exited, while the smallest would occur in the case of a PricewaterhouseCoopers exit.

Panel B looks at the client-level changes in consumer surplus that underlie these aggregate losses. As anticipated, the expected changes in consumer surplus are substantially larger for existing clients of an exiting audit firm than for nonclients.[22] The average expected loss in consumer surplus ranges (depending on the identity of the exiting audit firm) from $1.5 to $2.1 million for the exiting auditor's clients, while for nonclients the mean expected change in consumer surplus ranges from $9,000 to $14,000. With respect to correlations with firm characteristics, for clients of an exiting audit firm the expected changes in consumer surplus correlate positively with client size (correlation coefficients between 0.24 and 0.59), audit fees (0.65–0.84), and tenure with the audit firm (0.16–0.33). For nonclients, the expected changes in consumer surplus are basically uncorrelated with observable client characteristics; that is, they are primarily driven by the unobservable utility component, ϵ_{ij}.

These estimates are subject to several caveats. One factor that could mitigate the size of the estimated losses is the possibility that audit teams from

[22] Nonclients suffer a surplus loss from the exit of an audit firm they have not hired because they lose the option value of hiring that auditor.

the exiting audit firm move en masse with their clients to the remaining audit firms. Presumably, some of the match-specific utility would move with the teams even if the audit firm disappears as a legal entity. Consistent with this possibility, Blouin, Grein, and Rountree [2007] find that some Arthur Andersen clients followed their Andersen audit teams to the remaining Big 4 audit firms. Nonetheless, audit firms differ in factors such as technology, training, culture, and team structure. Hence, even if an audit team followed a client, there would likely be a utility loss due to differences in such factors.[23] Moreover, the implosion of Andersen led to a net loss of employees for Andersen, the Big 4, Grant Thornton, and BDO Seidman. Prior to its implosion, Andersen had approximately 28,000 employees in the United States. The net growth of employment in the remaining Big 4 plus Grant Thornton and BDO Seidman was, however, only 14,000, implying that half of Andersen's employees left this segment of the labor market.[24]

There are multiple reasons why these estimates might understate the true loss of client firms' consumer surplus. For one, the estimates do not include lost surplus tied to non-audit services (such as consulting and tax services) that audit firms might also provide to their clients. In addition, the estimates exclude any surplus lost by an exiting audit firm's domestic private or international clients.

Our estimates are calculated based on the disappearance of a Big 4 audit firm from clients' choice sets for only one year. If the persistence of audit firm-client matches is solely due to one-time costs of switching auditors, then our single-year estimates should capture most of the present value of the change in consumer surplus, as once the switch is forced by the counterfactual Big 4 exit, no further losses of this type would be induced. However, if persistence in auditor-client matches arises instead due to unobserved heterogeneity and match-specific capital, the estimates reflect only the first year's loss of the surplus created by these match-specific components, and the permanent demise of a Big 4 audit firm could impose similar losses for years into the future.

Out of curiosity, we used our methodology to compute the total change in client firms' surplus due to the exit of Arthur Andersen in 2002. To do so, we estimated the demand model using data from 2001 and then used the estimates to calculate surplus changes in the counterfactual as above. We found that total lost surplus due to Andersen's exit was $276 million in 2001 dollars (equivalent to $340 million in 2010). The average loss for a given Andersen client firm was $255,000 ($314,000 in 2010). These estimates are remarkably close in relative terms to ours above. Andersen's total

[23] For discussions of differences among audit firms and the problems encountered in audit firm mergers, see Prawitt [1995], Winograd, Gerson, and Berlin [2000], Empson [2004], and Jenkins et al. [2008]. For a discussion of the differences in information technology among the Big 4, see Carson and Dowling [2012].

[24] Employment data are taken from the Public Accounting Review's Annual Surveys of National Accounting Firms.

audit fees in 2001 were $476 million, so the lost consumer surplus was 58% of fees, right in the range we found above for the Big 4 during 2008–2010. Moreover, total fees across all audit firms in 2001 were $2.8 billion, so Andersen's loss was about 10% of that. This is of similar magnitude to our above findings of $1.3–$1.8 billion in lost consumer surplus per firm when total audit fees were about $11 billion in 2010.

4.3 SUPPLY-SIDE PRICING RESPONSES

As we have discussed, the counterfactual changes in surplus computed above hold audit fees fixed, isolating surplus changes due to demand-side effects only. In this section, we estimate what the supply-side responses might be under the counterfactual scenarios and quantify their additional impact on client firms' expected surplus.

To estimate the supply response, we first note that both counterfactual scenarios involve reductions in competition. In standard oligopoly models, reductions in competition—resulting from the actual exit of one of the market competitors in one counterfactual and the de facto exit of a client firm's former audit firm (at least for that client firm) in the other—lead to higher prices. Our estimate of the counterfactual audit fee changes due to the supply response works off this logic. Specifically, we estimate in our sample how changes in audit firm competition for clients within an industry relate to average audit fee changes in that industry.

A typical concern when estimating such relationships is that market structure and prices are both endogenous outcomes, making causal inference difficult. However, we are fortunate in that we have (and indeed have already used for demand estimation purposes above) an exogenous change in competition at the industry level, the collapse of Arthur Andersen. Thus, we can identify the causal relationship between competition and fees by estimating the semi-elasticity of audit fees in 2002 with respect to the share of assets Andersen audited in that (three-digit SIC) industry in 2001. We estimate this semi-elasticity using ordinary least squares, controlling for the standard audit fee determinants. Note that we estimate this effect for the period prior to the implementation of mandatory internal control audits under the Sarbanes-Oxley Act, so fee variation likely reflects changes in industry concentration rather than demand changes from increased regulatory requirements.[25] These results, which are presented in table 11, indicate that audit fees rise 0.15% for each percentage point of total industry assets that had been audited by Arthur Andersen before its collapse. We view this estimate as a lower bound of the upward pressure on fees because it is based solely on interindustry variation and therefore excludes overall increases in audit fees and increases based on groupings other than our industry classifications. Moreover, a drop from the Big 4 to a Big 3 could well lead to even greater increases in fees than the disappearance of Arthur Andersen.

[25] For a discussion and evidence on this point, see Feldman [2006] and Kohlbeck et al. [2008].

Panel A of table 12 uses this semi-elasticity to calculate the expected annual increase in total audit fees that would occur under each of the mandatory audit firm rotation horizons. These range from $730 million for the implementation of 10-year rotation in 2009 to $1.33 billion for 4-year rotation in 2010.

Panel B presents analogous fee increases if a Big 4 audit firm were to disappear. These estimates range from $360 million for the disappearance of Deloitte in 2009 or 2010 to $580 million for the disappearance of PricewaterhouseCoopers in 2008. The estimated annual increases in fees is smaller in this exit scenario than in the mandatory rotation case because a rotation mandate would affect a larger number of client firms.

When combined with the estimated demand-side losses in tables 9 and 10, the supply response implies estimated initial surplus losses among client firms totaling in the neighborhood of $3.4–3.5 billion (10-year maximum tenure) or $5.9–6.2 billion (four-year maximum tenure) in the case of mandatory audit firm rotation and $1.7–2.4 billion in the case of exit of one of the Big 4.

Note that these estimated fee increases are for a single year. New entry into the market (either by a new firm or, more likely, substantial expansion of one of the mid-tier audit firms in the industry) would determine the extent to which such annual increases in total audit fees persist into the future. Absent new entry, these increases in annual audit fees could persist indefinitely. The limited entry response subsequent to the collapse of Arthur Andersen suggests that such increases would likely be quite persistent.

5. *Conclusion*

Using estimates of publicly listed firms' demand for audit services, we evaluate the consequences for client firms of two important policy-related scenarios: the imposition of mandatory audit firm rotation and further concentration of the audit industry due to the exit of one of the Big 4 audit firms.

The estimated parameters of our model, which fit the data quite well, imply that both scenarios would impose substantial costs. The direct impacts on client firms' choice sets alone imply surplus losses of about $2.7–5.0 billion if audit firm rotation is mandated (with shorter mandated maximum tenures creating larger losses of surplus) and $1.4–1.8 billion for the exit of one of the Big 4. Factoring in the expected supply responses of the remaining audit firms—that is, the audit fee hikes expected due to decreased competition—raises these figures by another 25–30%. Moreover, there are several reasons why these estimated losses are likely to be conservative, including that these figures are for initial one-year surplus losses, while in reality both the loss of choice and increase in fees from less competition are likely to be persistent.

Nevertheless, it is important to note that these estimates do not comprehensively measure all possible market consequences of mandatory rotation

or increased concentration. Mandatory rotation and audit firm exit could yield social benefits as well. Forcing auditor rotation may reduce rent seeking if audit firms and clients become too close, and threatened exit due to malfeasance or negligence may discipline moral hazard. Estimating these effects would certainly be interesting but is beyond the scope of this study. What we have sought to do here is measure as accurately as possible the costs of such changes to a very important set of market participants, the client firms—the consumers in this market. And these costs are precisely what any optimal policy regarding audit firm concentration and mandatory rotation would need to balance possible benefits against.

While we have used our framework to address two of the more salient policy questions in the audit industry, we believe our empirical framework can be applied to other sets of economic questions about the industry, and purchased business services more broadly. Furthermore, we see potential gains from analyzing the audit industry in a more explicit economic framework that separates demand from supply effects to better understand the sources and consequences of shifts in the industry's market conditions.

APPENDIX

Additional Analyses

To validate our demand model, we test its ability to predict actual substitution patterns by using it to predict which audit firm former Andersen clients chose in 2002, after Andersen's collapse forced them to choose a new audit firm. Table A.1 lays out the results. Panel A presents three sets of demand estimates for 2002: the first column shows estimates obtained using only clients of Arthur Andersen in 2001; the second column uses all client firms in 2002; the third column uses a sample of all client firms that were not Andersen clients in 2001. We use these parameters to generate predicted probabilities of audit firm choice for Andersen clients in 2002. In general, these demand parameters are similar to those presented in table 7. Importantly, the price coefficient is similar both in sign and magnitude to the baseline estimates. Panel B presents elasticity estimates for Andersen clients based on parameter estimates from the three models. As can be seen, these estimates are similar to those presented in panel B of table 7.

We next compare the actual audit firm choices of Andersen clients in 2002 to the audit firm with the highest predicted choice probability according to the demand estimates in panel A of table A.1. These results are presented in table A.2. All three models provide better predictions than just chance. With one exception (Arthur Andersen clients in 2001 who hired PricewaterhouseCoopers in 2002, with estimates obtained using only the Andersen clients sample), the audit firm that the model predicts as most likely to be hired was in fact the audit firm that the client firm actually hired. Importantly, even parameters estimated using only non-Andersen clients have predictive ability for former Andersen client firms' choices.

TABLE A1

Demand and Price Elasticity Estimates for Arthur Andersen Clients

Panel A: Demand estimates for former Arthur Andersen clients in 2002

	Andersen Clients	All Clients	Non-Andersen Clients
Ln(Predicted Fees)	−2.114***	−1.968***	−1.925***
	(0.193)	(0.069)	(0.074)
E&Y	−1.383	−1.238***	−1.269***
	(0.964)	(0.255)	(0.269)
Deloitte	−2.697***	−1.885***	−1.833***
	(1.008)	(0.267)	(0.281)
KPMG	−1.775*	−1.643***	−1.664***
	(0.962)	(0.253)	(0.266)
PwC	−1.599	−1.763***	−1.768***
	(1.016)	(0.262)	(0.272)
E&Y Ln(Assets)*	0.869***	0.670***	0.663***
	(0.167)	(0.038)	(0.039)
Deloitte Ln(Assets)*	1.014***	0.669***	0.642***
	(0.171)	(0.039)	(0.040)
KPMG Ln(Assets)*	0.873***	0.656***	0.641***
	(0.167)	(0.038)	(0.039)
PwC Ln(Assets)*	0.896***	0.765***	0.756***
	(0.171)	(0.038)	(0.039)
E&Y Ln(Segments)*	−0.039	−0.021	−0.071
	(0.250)	(0.072)	(0.076)
Deloitte Ln(Segments)*	−0.128	−0.015	−0.041
	(0.258)	(0.074)	(0.079)
KPMG Ln(Segments)*	−0.546**	−0.130*	−0.108
	(0.252)	(0.074)	(0.078)
PwC Ln(Segments)*	−0.536**	−0.203***	−0.198**
	(0.266)	(0.074)	(0.077)
E&Y Foreign Sales*	−0.461	0.299**	0.346**
	(0.542)	(0.148)	(0.155)
Deloitte Foreign Sales*	−0.479	0.226	0.284*
	(0.567)	(0.157)	(0.165)
KPMG Foreign Sales*	0.135	0.715***	0.772***
	(0.542)	(0.153)	(0.162)
PwC Foreign Sales*	0.141	0.876***	0.895***
	(0.567)	(0.150)	(0.156)
E&Y Debt*	−1.712**	−0.838***	−0.830***
	(0.757)	(0.213)	(0.226)
Deloitte Debt*	−1.545*	−0.378	−0.344
	(0.808)	(0.233)	(0.247)
KPMG Debt*	−0.963	0.042	0.115
	(0.778)	(0.223)	(0.237)
PwC Debt*	−2.155***	−0.743***	−0.628***
	(0.835)	(0.220)	(0.230)
E&Y ROA*	0.723	−1.114***	−1.337***
	(0.760)	(0.246)	(0.264)
Deloitte ROA*	1.463*	−0.145	−0.310
	(0.868)	(0.281)	(0.300)
KPMG ROA*	0.301	−0.912***	−0.995***
	(0.752)	(0.258)	(0.280)

(*Continued*)

TABLE A1—*Continued*

Panel A: Demand estimates for former Arthur Andersen clients in 2002

	Andersen Clients	All Clients	Non-Andersen Clients
PwC ROA*	1.167	−0.710***	−0.878***
	(0.846)	(0.259)	(0.275)
E&Y Inventory + Receivables*	1.018	−1.031***	−1.029***
	(1.178)	(0.282)	(0.294)
Deloitte Inventory + Receivables*	1.038	−0.493	−0.463
	(1.259)	(0.306)	(0.318)
KPMG Inventory + Receivables*	1.818	−0.599**	−0.701**
	(1.168)	(0.284)	(0.299)
PwC Inventory + Receivables*	2.339*	−0.873***	−1.007***
	(1.246)	(0.294)	(0.305)
E&Y Payables*	−2.936**	−2.878***	−3.011***
	(1.326)	(0.354)	(0.374)
Deloitte Payables*	−3.844***	−2.784***	−2.734***
	(1.428)	(0.368)	(0.385)
KPMG Payables*	−2.912**	−2.451***	−2.423***
	(1.249)	(0.327)	(0.346)
PwC Payables*	−4.067***	−3.639***	−3.712***
	(1.391)	(0.371)	(0.390)
Industry Interactions with Brand Fixed Effects	Yes	Yes	Yes
Observations	3,784	28,854	25,070

Panel B: Mean price elasticity estimates for former Arthur Andersen clients in 2002

	Demand Parameters Estimated Using		
	Andersen Clients	All Clients	Non-Andersen Clients
E&Y	–1.502	−1.498	−1.475
Deloitte	−1.672	−1.640	−1.610
KPMG	−1.527	−1.576	−1.560
PwC	−1.776	−1.532	−1.476
Non–Big 4	−1.977	−1.627	−1.577

This table presents demand estimates and price elasticity estimates for former Arthur Andersen clients in 2002. Panel A presents demand estimates: column (1) presents estimates of audit firm choice in 2002 for firms that were clients of Arthur Andersen in 2001; column (2) presents estimates of audit firm choice in 2002 for all firms; column 3 presents estimates of audit firm choice in 2002 for firms that were not clients of Arthur Andersen in 2001. For all three regressions, the outside good consists of the non–Big 4 audit firms. *Ln(Predicted Fees)* is the natural logarithm of predicted fees for each of the Big 4 audit firms. *E&Y, Deloitte, KPMG,* and *PwC* are brand fixed effects for each of the Big 4 audit firms. *Ln(Assets)* is the natural logarithm of the client's total assets, *Ln(Segments)* is the natural logarithm of the client's industrial segments, *Foreign Sales* is the percentage of the client's sales generated outside of the United States, *Debt* is the ratio of short- and long-term debt to total assets for the client, *ROA* is the client's return on assets, *Inventory + Receivables* is the client's ratio of inventory and receivables to total assets, and *Payables* is the ratio of the client's account payables to total assets. Not tabulated are interactions between the brand fixed effects and indicators for the Fama-French 10 industries. Panel B presents price elasticity estimates for former Arthur Andersen clients based on the parameter estimates from the three regressions presented in panel A.

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

TABLE A2

Actual Choices of Arthur Andersen Clients Compared to Model Predictions

Panel A: Conditional logit estimated on Arthur Andersen clients

		Highest Predicted Probability					
		E&Y	Deloitte	KPMG	PwC	Non–Big 4	Total
Actual choice	E&Y	133	20	53	7	6	219
		60.7%	*9.1%*	*24.2%*	*3.2%*	*2.7%*	
	Deloitte	40	69	40	7	2	158
		25.3%	*43.7%*	*25.3%*	*4.4%*	*1.3%*	
	KPMG	51	18	129	8	4	210
		24.3%	*8.6%*	*61.4%*	*3.8%*	*1.9%*	
	PwC	31	18	38	32	2	121
		25.6%	*14.9%*	*31.4%*	*26.4%*	*1.7%*	
	Non–Big 4	14	4	14	1	16	49
		28.6%	*8.2%*	*28.6%*	*2.0%*	*32.7%*	
	Total	269	129	274	55	30	

Panel B: Conditional logit estimated on all clients

		Highest Predicted Probability					
		E&Y	Deloitte	KPMG	PwC	Non–Big 4	Total
Actual choice	E&Y	129	12	21	39	18	219
		58.9%	*5.5%*	*9.6%*	*17.8%*	*8.2%*	
	Deloitte	43	60	15	36	4	158
		27.2%	*38.0%*	*9.5%*	*22.8%*	*2.5%*	
	KPMG	51	9	93	37	20	210
		24.3%	*4.3%*	*44.3%*	*17.6%*	*9.5%*	
	PwC	29	9	20	58	5	121
		24.0%	*7.4%*	*16.5%*	*47.9%*	*4.1%*	
	Non–Big 4	21	2	2	1	23	49
		42.9%	*4.1%*	*4.1%*	*2.0%*	*46.9%*	
	Total	273	92	151	171	70	

Panel C: Conditional logit estimated on non-Arthur Andersen clients

		Highest Predicted Probability					
		E&Y	Deloitte	KPMG	PwC	Non–Big 4	Total
Actual choice	E&Y	129	12	21	39	18	219
		58.9%	*5.5%*	*9.6%*	*17.8%*	*8.2%*	
	Deloitte	43	60	15	36	4	158
		27.2%	*38.0%*	*9.5%*	*22.8%*	*2.5%*	
	KPMG	51	9	93	37	20	210
		24.3%	*4.3%*	*44.3%*	*17.6%*	*9.5%*	
	PwC	29	9	20	58	5	121
		24.0%	*7.4%*	*16.5%*	*47.9%*	*4.1%*	
	Non–Big 4	21	2	2	1	23	49
		42.9%	*4.1%*	*4.1%*	*2.0%*	*46.9%*	
	Total	273	92	151	171	70	

This table compares predicted with actual audit firm choices in 2002 for firms that were clients of Arthur Andersen in 2001. Panel A uses the highest predicted probability from the model estimated on all clients presented in column (1) of table A1. Panel B uses the highest predicted probability based on the model estimated only on Arthur Andersen clients presented in column (2) of table A1. Panel C uses the highest predicted probability from the model estimated on firms that were not Arthur Andersen clients presented in column (3) of table A1. The percentages in italics are relative to the row totals.

TABLE A3

Comparison of RMSEs for the Prediction Methods

Panel A: Number of times each method has the lowest RMSE

Auditor	Year	ols	lasso	ridge	pls	rpart	rfor
E&Y	2002	6,402	14,341	6,592	11,744	39,787	58,934
	2003	8,342	15,331	6,915	14,262	40,259	51,691
	2004	9,846	19,815	5,638	12,936	35,402	41,963
	2005	8,621	16,467	5,712	12,492	35,714	44,594
	2006	8,111	20,463	6,182	9,268	33,318	43,558
	2007	7,457	19,365	5,291	10,037	32,756	44,394
	2008	6,117	17,873	4,518	8,165	31,693	44,134
	2009	5,273	16,130	4,444	8,163	29,453	42,137
	2010	5,786	16,545	4,543	8,511	29,105	40,410
Deloitte	2002	6,448	13,063	4,543	7,180	26,519	38,747
	2003	5,786	11,514	4,974	8,753	25,807	39,966
	2004	6,208	10,697	5,413	9.950	23,757	37,475
	2005	6,190	11,708	5,375	9,148	24,813	34,366
	2006	6,560	11,553	5,026	9,578	24,269	29,214
	2007	7,241	12,891	4,735	8,850	23,041	26,442
	2008	6,250	11,483	4,250	8,395	22,158	25,664
	2009	6,209	9,742	4,705	6,717	22,467	24,460
	2010	5,451	9,398	4,609	6,530	23,314	25,498
KPMG	2002	5,762	8,795	5,377	9,714	25,771	59,681
	2003	5,304	10,089	4,946	8,929	31,246	52,686
	2004	6,113	13,128	5,560	10,225	28,413	43,861
	2005	7,291	10,077	6,602	9,153	24,665	39,112
	2006	5,479	11,940	5,362	8,627	22,126	36,966
	2007	5,382	11,049	5,054	7,565	20,458	33,592
	2008	5,607	9,087	4,231	6,389	19,859	32,627
	2009	4,834	7,795	4,333	6,552	19,545	30,941
	2010	4,900	8,589	3,649	6,185	21,951	30,626
PwC	2002	6,665	17,084	5,615	9,416	34,046	55,074
	2003	8,645	15,449	6,255	10,076	35,597	51,878
	2004	9,366	15,390	7,252	12,245	32,589	42,758
	2005	8,982	15,412	5,713	11,431	28,406	36,056
	2006	6,621	13,467	5,254	7,976	27,858	35,324
	2007	5,759	12,226	4,664	8,142	26,255	33,154
	2008	5,084	10,887	3,920	7,608	24,095	33,806
	2009	5,045	8,499	3,929	7,333	23,385	30,809
	2010	5,128	8,674	4,814	7,554	24,344	29,786
Non–Big 4	2002	6,470	11,016	6,179	10,436	23,294	42,805
	2003	6,969	13,259	6,185	11,615	33,842	44,130
	2004	12,046	18,297	9,303	17,219	32,082	50,653
	2005	16,959	26,575	10,068	22,505	39,704	53,789
	2006	19,256	27,245	11,404	26,848	45,079	55,968
	2007	17,433	29,294	12,350	25,414	50,938	61,471
	2008	17,634	32,056	11,439	24,591	43,635	58,145
	2009	18,988	28,877	11,064	22,308	42,300	50,663
	2010	16,507	28,354	11,648	21,039	40,378	46,974

Panel B: Average rank of each method

Auditor	Year	ols	lasso	ridge	pls	rpart	rfor
E&Y	2002	4.32	3.86	3.88	4.24	2.52	2.16
	2003	4.25	3.89	3.85	4.07	2.62	2.31

(*Continued*)

TABLE A3—*Continued*

Panel B: Average rank of each method

Auditor	Year	ols	lasso	ridge	pls	rpart	rfor
	2004	4.12	3.76	3.81	3.95	2.84	2.53
	2005	4.10	4.02	3.79	4.00	2.72	2.37
	2006	4.18	3.60	3.82	4.18	2.82	2.38
	2007	4.20	3.60	3.84	4.21	2.77	2.38
	2008	4.25	3.61	3.91	4.24	2.70	2.28
	2009	4.32	3.57	3.93	4.28	2.67	2.23
	2010	4.27	3.59	3.90	4.26	2.72	2.26
Deloitte	2002	4.23	3.67	3.98	4.25	2.65	2.22
	2003	4.17	4.14	3.83	4.01	2.62	2.22
	2004	4.27	3.91	3.85	4.02	2.70	2.25
	2005	4.17	3.90	3.81	4.03	2.76	2.32
	2006	4.12	3.91	3.76	3.99	2.77	2.46
	2007	4.05	3.72	3.74	4.07	2.88	2.55
	2008	4.12	3.72	3.78	4.08	2.83	2.47
	2009	4.10	3.83	3.75	4.11	2.74	2.47
	2010	4.17	3.82	3.78	4.10	2.67	2.45
KPMG	2002	4.43	3.93	3.90	4.21	2.59	1.95
	2003	4.43	3.92	3.93	4.23	2.47	2.02
	2004	4.28	3.80	3.86	4.16	2.69	2.20
	2005	4.20	3.97	3.76	4.10	2.74	2.23
	2006	4.24	3.78	3.85	4.10	2.83	2.21
	2007	4.25	3.82	3.81	4.11	2.81	2.21
	2008	4.26	3.82	3.81	4.18	2.73	2.20
	2009	4.24	3.91	3.78	4.16	2.68	2.22
	2010	4.33	3.90	3.87	4.14	2.56	2.21
PwC	2002	4.35	3.64	3.96	4.27	2.66	2.12
	2003	4.31	3.76	3.92	4.20	2.61	2.21
	2004	4.09	4.03	3.72	3.99	2.72	2.45
	2005	4.06	3.92	3.73	3.99	2.80	2.50
	2006	4.14	3.73	3.79	4.18	2.76	2.40
	2007	4.23	3.75	3.83	4.14	2.72	2.34
	2008	4.22	3.77	3.88	4.16	2.69	2.27
	2009	4.24	4.10	3.84	4.05	2.54	2.23
	2010	4.21	4.08	3.80	4.04	2.55	2.32
Non–Big 4	2002	4.35	3.75	3.72	4.21	2.72	2.25
	2003	4.45	3.60	3.91	4.21	2.56	2.26
	2004	3.97	3.93	3.60	4.02	3.01	2.46
	2005	3.80	3.84	3.57	3.88	3.19	2.73
	2006	3.72	3.78	3.54	3.86	3.31	2.79
	2007	3.75	4.20	3.50	3.83	3.10	2.62
	2008	3.74	4.07	3.50	3.83	3.23	2.63
	2009	3.70	4.13	3.45	3.88	3.19	2.66
	2010	3.75	4.15	3.50	3.91	3.08	2.61

Panel C: Median rank of each method

Auditor	Year	ols	lasso	ridge	pls	rpart	rfor
E&Y	2002	5	3	4	4	2	2
	2003	5	4	4	4	2	2
	2004	4	4	4	4	2	2
	2005	4	4	4	4	2	2
	2006	4	3	4	4	2	2

(*Continued*)

TABLE A3—*Continued*

Panel C: Median rank of each method

Auditor	Year	ols	lasso	ridge	pls	rpart	rfor
	2007	5	3	4	4	2	2
	2008	5	3	4	4	2	2
	2009	5	3	4	4	2	2
	2010	5	3	4	4	2	2
Deloitte	2002	5	3	4	4	2	2
	2003	4	4	4	4	2	2
	2004	5	4	4	4	2	2
	2005	4	4	4	4	2	2
	2006	4	4	4	4	2	2
	2007	4	4	4	4	2	2
	2008	4	4	4	4	2	2
	2009	4	4	4	4	2	2
	2010	4	4	4	4	2	2
KPMG	2002	5	4	4	4	2	1
	2003	5	4	4	4	2	2
	2004	5	4	4	4	2	2
	2005	5	4	4	4	2	2
	2006	5	4	4	4	2	2
	2007	5	4	4	4	2	2
	2008	5	4	4	4	2	2
	2009	5	4	4	4	2	2
	2010	5	4	4	4	2	2
PwC	2002	5	3	4	4	2	2
	2003	5	3	4	4	2	2
	2004	4	4	4	4	2	2
	2005	4	4	4	4	2	2
	2006	4	3	4	4	2	2
	2007	5	3	4	4	2	2
	2008	4	3	4	4	2	2
	2009	5	4	4	4	2	2
	2010	5	4	4	4	2	2
Non–Big 4	2002	5	3	4	4	2	2
	2003	5	3	4	4	2	2
	2004	4	4	4	4	2	2
	2005	4	4	4	4	3	2
	2006	4	4	4	4	3	2
	2007	4	5	4	4	3	2
	2008	4	5	4	4	3	2
	2009	4	5	4	4	3	2
	2010	4	5	4	4	3	2

This table presents the results of the comparison of methods to predict audit fees. To evaluate the best method to predict audit fees, we compared six regression methods that are commonly used in forecasting applications: ordinary least squares, `ols`; lasso regression, `lasso`; ridge regression, `ridge`; partial least squares, `pls`; recursive partitioning, `rpart`; and randomForest, `rfor`. For each auditor-year pair, we used the six regression methods to generate RMSEs using 100 repetitions of fivefold cross-validations. As predictors of audit fees, we include the natural logarithm of total assets, the natural logarithm of industrial segments, the percentage of foreign sales, the ratio of debt to total assets, the ratio of inventory and receivables to total assets, the ratios of payables to total assets, the number of years as client of the audit firm, indicator variables for the Fama-French 10 industry classification, and the ratio of three-digit SIC industry assets audited by Arthur Andersen to total industry assets in 2001. In panel A, each cell represents the number of times the regression method has the minimum RMSE for the audit-year pair. Panel B presents the average rank of each regression method's RMSE for each auditor-year pair and panel C presents the median rank.

TABLE A4

Evaluation of Whether the Andersen Supply Shifter Improves Predictive Ability

	E&Y	Deloitte	KPMG	PwC	Non–Big 4
2002	12.12	26.28	10.16	19.98	8.34
2003	15.48	2.80	22.20	19.45	−5.06
2004	32.26	2.31	15.99	5.62	−2.53
2005	20.06	7.19	21.00	10.58	22.83
2006	30.56	8.26	24.35	7.34	8.89
2007	23.34	8.13	21.15	16.41	4.78
2008	20.77	9.35	20.06	14.97	20.83
2009	14.50	7.69	15.60	5.01	15.12
2010	11.09	9.73	23.82	11.41	13.53

This table evaluates whether the Andersen supply shifter improves the ability of the randomForest specification to predict fees. For each auditor-year pair, we generate differences between the root squared errors for predictions that include and do not include the Andersen shifter using 100 repetitions of fivefold cross validations. To calculate differences, we subtract the root squared error of the specification that includes the Andersen shifter from the root squared error that excludes it so that the difference represents the improvement in predictive ability. The table presents *t*-values for whether the mean of the distribution of differences is greater than zero.

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